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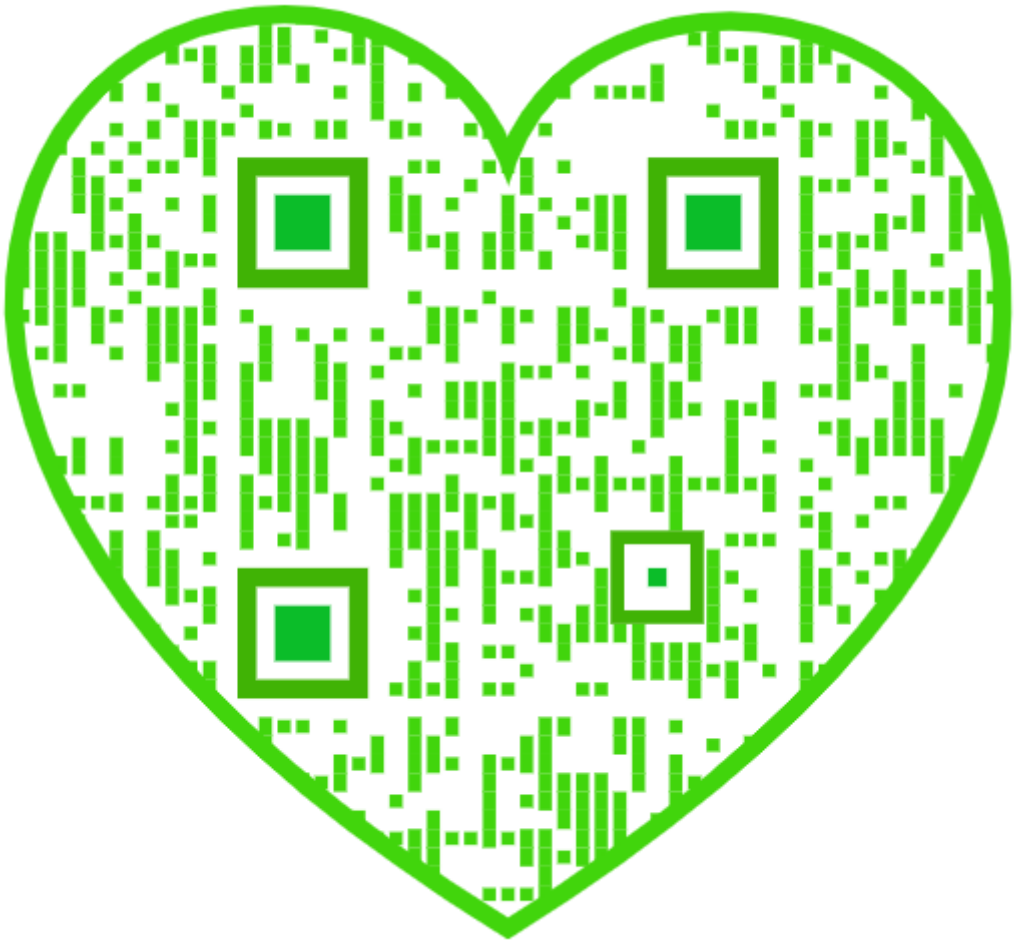

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# FOREST NURSERIES AND NURSERY METHODS IN EUROPE

BY
WILLIAM F. FOX

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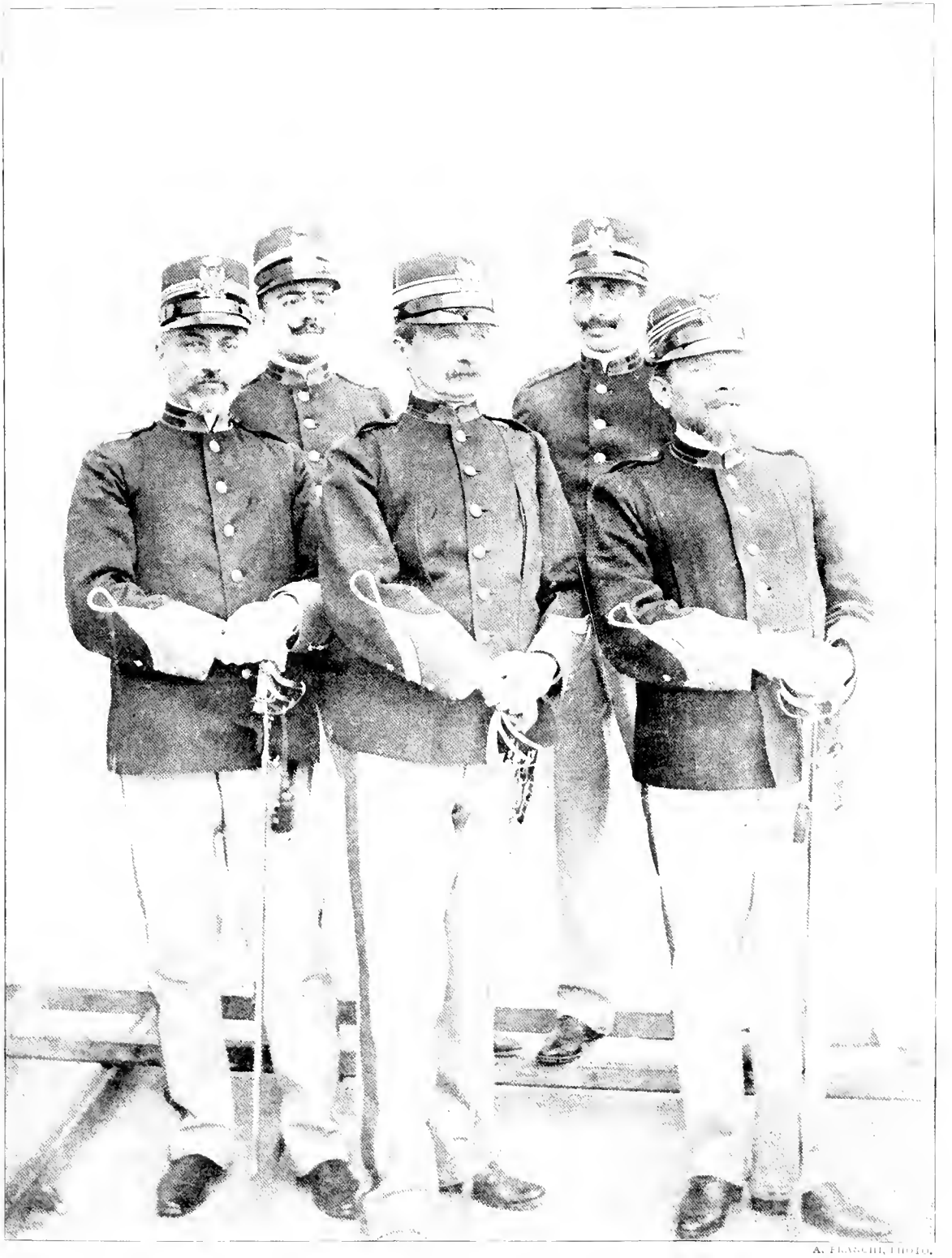


A. FLASCHI, PHOTO.

ITALIAN FORESTERS.

OFFICERS OF THE FORESTRY DEPARTMENT, FLORENCE, ITALY.

# Forest Nurseries and Nursery Methods in Europe

By William F. Fox.

## Introductory.

IN the management of American forests the time has come when it would seem evident to all interested in the work that the future timber supply in many localities is dependent on reforestation. But natural reforestation is unsatisfactory from the forester's point of view. In results it falls short, by far, of the maximum in quantity and quality of merchantable timber which a given area can be made to yield through proper methods of silvicultural work.

The highly satisfactory results attained from planted forests in Europe, where this practice has been followed for two centuries or more, justifies clearly the adoption of this system in America. The New Forest in England was "afforested" by order of William the Conqueror, in 1079, and since then reforestation has been practiced from time to time in European countries, until cultivated forests are now the rule rather than the exception. Throughout Germany, France, Belgium and Italy most of the wooded areas show high forests of a density and regularity that indicate plainly their artificial growth. For these and other reasons the planting of forests is engaging the attention of American foresters today. It is no new idea.

A planted forest, like the primitive one, is grown from seed, but in the former the dissemination is under intelligent control. This may be done by broadcast sowing, by the seed-spot method, or by the intermediate process of raising small seedlings in garden or nursery beds; and, large areas of trees are propagated from wind-sown seeds, skilfully directed and managed.

Broadcast sowing may be a desirable method under certain conditions where economy is necessary, where a supply of seedling plants cannot be obtained conveniently, or where a rocky, uneven surface, covered with a scrubby growth, compels its use. But it has the disadvantages of uncertainty, irregularity and the subsequent expense of filling in the blanks where seeds failed to germinate. As the planting of seedlings at regular intervals gives the forester better control

of his future work, this plan is in general use abroad. It necessitates, however, the establishment of nurseries for the propagation of the young plants.

The management of tree nurseries, in connection with forest plantations, has been carried on for so many years in Europe that the American forester who is about to engage in this branch of silvicultural work will find there an ample field in which to study and gain the information available for similar efforts. These nurseries will be found in most of the forest regions abroad—the *baumschule* in Germany, the *pepinière* in France, and the *piantonaio* in Italy. The object of these pages is to describe briefly, but as plainly as possible, the technical methods employed in the forest nurseries of various European countries.

For this purpose the descriptions are confined to certain ones in which the construction and management are fairly typical of the others in that particular country. To attempt more would involve needless repetition and unnecessarily extend the scope and province of this article.

## Italy.

We have heard so much of German forestry and its superior methods that our American foresters, when they go abroad for study and information, are too apt to devote their time exclusively to travel within Germany. It would be well if, when not limited as to time or expense, they were to extend their observations to some of the other continental forests and nurseries. But few of our foresters seem to have paid any attention to Italy. This may be due to the small percentage of woodlands in that country. But the Italian Government is steadily increasing its forest areas, and is conducting silvicultural operations of a high order.

The nurseries have an annual output of about 9,000,000 plants, and new plantations of large areas are made each year. The surplus seedlings, or transplants, not necessary for fieldwork are distributed free to persons who may need them in reforesting private lands.

The location, area and product of the various nurseries maintained by the Italian Government are as follows:

| PROVINCE. | Name of the forest nursery. | Area in hectares | Yearly expenditure for maintenance. | Number of plants produced. |
|---|---|---|---|---|
| | | | Francs. | |
| Firenze | Vallombrosa | 5.4538 | 6,538.25 | 1,000,000 |
| Arezzo | Camaldoli | 7.3354 | 6,203.00 | 800,000 |
| Firenze | Boscolungo | 2.0605 | 2,978.40 | 660,000 |
| Belluno | Pian Spini | 2.6830 | 3,071.70 | 1,200,000 |
| Bergamo | Pradomi | 1.6022 | 660.18 | 140,000 |

| PROVINCE | Name of the forest nursery | Area in hectares | Yearly expenditure for maintenance | No. of plants |
|---|---|---|---|---|
| | | | Francs. | |
| Brescia | Begotta | 2000 | 250 00 | 2,000,000 |
| Cagliari | Are, Mantoppi | 1 8000 | 883 42 | 110,000 |
| Caserta | Bandio | 1 1030 | 270 15 | 100,000 |
| Chieti | Marnee | 2 0470 | 1,500 48 | 300,000 |
| Cosenza | Migliano | 10,0000 | 2,365 03 | 1000,000 |
| Foggia | Giacomelli | 1 0000 | 650 91 | 100,000 |
| Genova | Trincata | 1 2000 | 900 33 | 125,000 |
| Grosseto | Follonica | 4 0107 | 4,235 00 | 2,500,000 |
| Macerata | San Giuseppe | 1,5000 | 850 41 | 35,000 |
| Novara | Alder | 3,8000 | 2,771 39 | 500,000 |
| Palermo | Lavatoio | 4 2000 | 2,504 40 | 400,000 |
| Potenza | Vigna | 0416 | 1,232 38 | 200,000 |
| Sassari | Frangada Pisanu | 2,0004 | 743 40 | 130,000 |
| Teramo | Buragni Paggiuca | 2 1814 | 1,268 00 | 118,000 |
| Total | | 58 1001 | 141,028 30 | 8,078,000 |

[1] A hectare is equal to 2.471 acres. [2] Or, $7,705.43.

The above statement will give some idea of the large extent to which nurseries are used by European governments in their work of forest extension. In Germany and France the nurseries are much more numerous, owing to the larger area of forest, greater amount of timber cutting, and more extensive replanting.

The different species of trees propagated in these Italian nurseries are shown in the following list, which was kindly furnished by Inspector A. Franchi, of the Forestry Department of Tuscany. The botanical designations, some of which are not used in this country, are as given in his list, and include some species which are rare in America:

| | |
|---|---|
| Silver fir | *Abies alba* Willd. (*Pinus picea* Linn.) |
| Norway spruce | *Abies picea* Willd. (*Pinus abies* Linn.) |
| Norway maple | *Acer platanoides* Linn |
| Sycamore maple | *Acer pseudo-platanus* Linn. |
| European alder | *Alnus glutinosa* Gaertn. |
| Speckled alder | *Alnus incana* Willd. |
| Chestnut | *Fagus castanea* Linn. |
| Beech | *Fagus sylvatica* Linn. |
| European ash | *Fraxinus excelsior* Linn. |
| Flowering ash | *Fraxinus ornus* Linn. |
| Walnut | *Juglans regia* Linn. |

| | |
|---|---|
| Larch | *Larix europaea* Dec. |
| Austrian pine | *Pinus austriaca* Reich. |
| Aleppo pine | *Pinus halepensis* Mill. |
| Corsican pine | *Pinus laricio* Poir. |
| Maritime pine | *Pinus pinaster* Ait. |
| Stone pine | *Pinus pinea* Linn |
| Scotch pine | *Pinus sylvestris* Linn. |
| Turkey oak | *Quercus cerris* Linn. |
| Holly or evergreen oak | *Quercus ilex* Linn. |
| English oak | *Quercus robur* Linn. |
| Siberian oak | *Quercus sessiliflora* Smith. |
| Cork oak | *Quercus suber* Linn. |
| Locust | *Robinia pseudo-acacia* Linn. |
| Basswood | *Tilia grandifolia* Smith. |
| English elm | *Ulmus campestris* Linn |
| Cypress | *Cupressus sempervirens* Linn. |

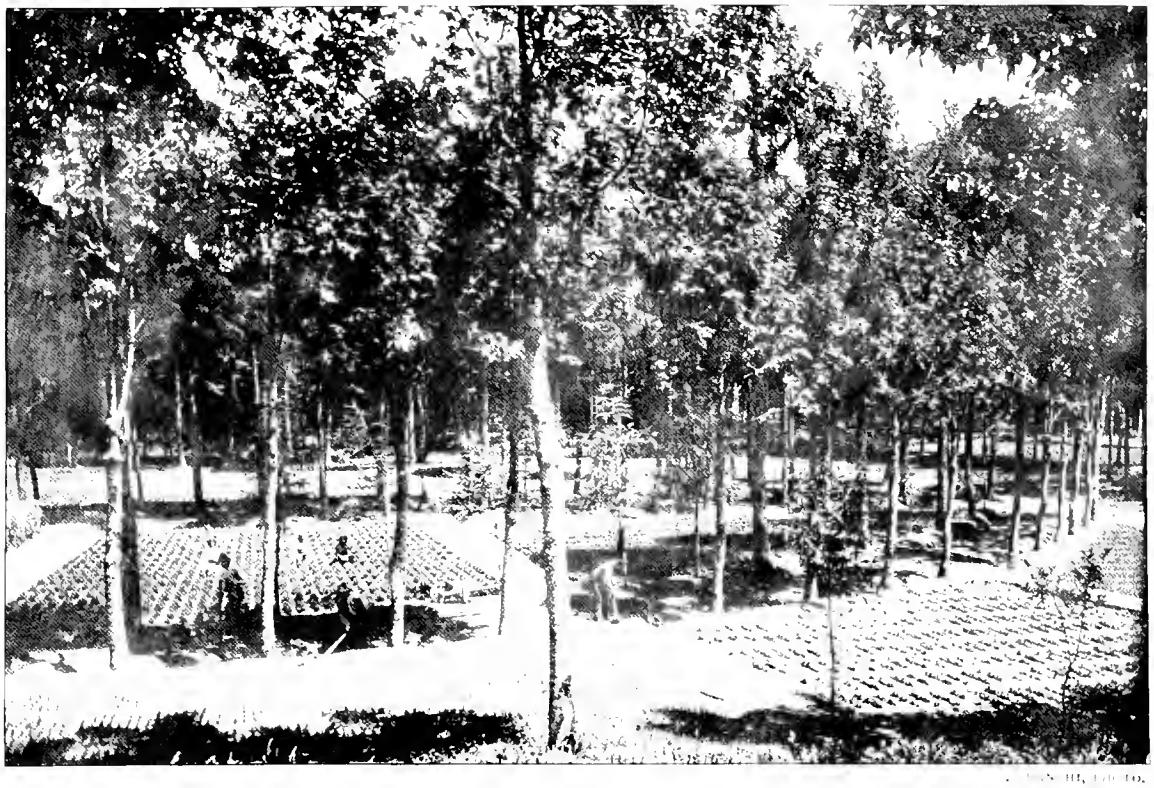
Besides these forest nurseries there are those belonging to the societies for the replanting of forests, which receive subsidies from the government.

In the forest nurseries of the government additional native plants are cultivated as well as many foreign species. This year at Vallombrosa and Camaldoli the hard, or sugar, maple, *Acer saccharum* Marsh will be cultivated from seeds furnished by the Forestry Department of New York.

At Camaldoli are some of the finest forests in Europe and a large nursery that, in size and cultural methods, will compare favorably with any. In most of the forest managements abroad a preference is given to small nurseries, of two acres or less, distributed so that each will be near the place where the seedlings will be planted. But at Camaldoli and Migliano large areas have been set apart for the propagation of seedling trees, and nearly all the public forests in Italy are supplied with young plants from these nurseries.

Camaldoli is in the Apenines, Province of Tuscany, and should not be confounded with the well-known place of that name near Naples. The former is easily reached by rail from Florence to Arezzo, thence by a branch railroad to Bibbiena, and thence by a drive of fifteen miles up the mountain pass to the old monastery which has been converted by the government into a commodious, fashionable hotel.

The nursery, or *piantonaio*, at this place covers about thirteen acres, and has an altitude of 2,910 feet above the sea. The ground, which has a gentle slope to the northeast, is laid out in terraces so as to afford a level situation for the beds. The exposure is favorable, as it furnishes protection from late frosts and



NURSERY BEDS SHADED BY PLANTED TREES.

AT CAMALDOLI, PROVINCE OF TUSCANY, ITALY.

FOREST TREE NURSERY, ITALY.

WEEDING THE TRANSPLANT BEDS.

the rapid evaporation caused by south winds. Although not closely surrounded on all sides by high forests, there is a dense tree growth near by of various age classes. Owing to the altitude the natural soil is thin and poor, but the entire surface of the nursery is deeply covered with rich, friable earth composed largely of humus mixed with fertilizers. It has the appearance of a fine loam, with no black earth in it aside from that brought from the forest near by, and with enough clay and sand to give it a light color.

The beds for conifers are four feet wide, and of various lengths to suit the terraces, most of the beds being about thirty feet long. The greater part of the area is occupied by transplants, the seed beds needing comparatively small space.

In preparing the seed beds the seeds are planted in rows running across the beds. Formerly the seeds were sown broadcast in these beds, but this was abandoned because, as claimed by the forester in charge, by sowing in rows a much smaller amount of seed is used, the plants grow stronger and more even in size, are more easily weeded, and can be taken up with less work and injury to the roots.

The seedlings are taken from the seed beds when two years old and transplanted into the long beds, where they remain two or three years more. The transplants are then four or five years old, from twelve to eighteen inches high, and are ready for transfer to the grounds where the final planting for the future forest is made. The Italian foresters seldom use two-year-old seedlings in their fieldwork, preferring to wait for the four-year-old transplants on account of the advantages which the latter have in size, hardiness and better root system.

The plants are allowed to remain in the seed beds and transplant beds respectively as follows:

| | Seed beds, years. | Transplant beds, years. | Removal to plantation, at, years. |
|---|---|---|---|
| Spruce | 2 | 3 | 5 |
| Pine | 2 | 2 | 4 |
| Larch | 2 | 2 | 4 |
| Beech | 2 | 1 | 3 |
| Oak | 2 | 1 | 3 |
| Maple | 2 to 3 | 2 | 4 to 5 |
| Ash | 2 | 1 | 3 |

The locusts are not transplanted in the nursery, but are taken from the seed beds when they are one year old and sent directly to the final plantation in the field

The principal species growing in the Camaldoli nursery are: Silver fir, Norway spruce, longleaf pine, stone pine, Austrian pine, larch, beech, chestnut and sycamore maple.

No lath frames are used for shade. Protection from heat and drought is obtained when necessary by using pine brush, which is stuck into the ground on the sunny side of the beds. Screens of thatched straw are also used for the same purpose. Unlike other nurseries in Europe, small trees, twenty-five feet in height, or thereabouts, are standing at intervals of twenty feet throughout the greater part of the area, and their moving shade contributes to the refreshment and protection of the tender plants. An ample supply of water for irrigation is obtained from a small, artificial lake situated on the side of a hill just above the nursery.

The beds containing the transplants are kept in fine condition, all the plants being alive and green, and at even spaces in the rows. In some of the seed beds, however, bare spots may be seen at times, due to the destructive work of birds and squirrels. These blanks are also liable to occur after an unusually wet season, when the excessive moisture prevents to some extent the germination of the seeds.

The management of this nursery is in charge of a forestry official who is termed in Italy a "brigadier," a title somewhat puzzling to the foresters of other countries who may have served in the army. The work of preparing, planting and weeding the beds is done almost wholly by women at daily wages of about thirty cents each. One woman will set out about 1,200 seedlings in the transplant beds in a day, a day's work being counted as ten hours. Hence the cost of transplants is only one fourth of that in American nurseries.

Although somewhat of a digression, some mention seems pardonable here of the high forest about Camaldoli, which consists mostly of silver fir, unmixed with other woods. An hour's walk to Sacre Eremo takes one over a good road through the best of the timber, and affords an opportunity to see this famous species in a very heavy stand per acre. The trees are tall, straight and of large diameter, the dense growth indicating a possible yield of 70,000 feet, board measure, per acre, exclusive of the minor product. It was planted by the monks of Camaldoli over a century ago. Protection from fire is attained by patrols, and by watchmen posted in little cabins placed on surrounding hilltops and mountain peaks, from which they announce by signals the first appearance of smoke.

But on this tract, containing 3,000 acres, no cutting is seen. In 1901 the government enacted a law that no timber should be cut in a public forest within a certain distance of any summer resort. Perhaps the Italian legislators had read the restrictions in the forestry clause of the State Constitution of New York and

followed that. The proprietor of the hotel at Camaldoli seemed satisfied with this embargo on lumbering in his immediate vicinity, and lamented the fact that on an adjoining tract of 10,000 hectares (25,000 acres) a fine forest was being cleared away by its non-resident owner, a member of the Austrian nobility.

At Vallombrosa there is also a well-managed nursery belonging to the Forestry Institute at that place. It is in Tuscany, and the forester desirous of visiting this famous resort can go by rail from Florence to San Ellero, thence by a cog-wheel railway up the mountain, five miles, to Saltino. From the latter place it is only a few minutes' walk to the Hotel di Foresta and the "Istituto Forestale" at Vallombrosa. The nursery at this place is on the college grounds, with an altitude of 3,050 feet. The air is quite cool in summer, although the temperature may be excessively warm in the Tuscan valleys. A high elevation is a desirable condition for a forest nursery in this latitude.

The plot contains between one and two acres, and is situated on a level terrace surrounded by groves of forest trees. It is further sheltered from wind by the mountain which, densely covered with tall firs, slopes upward from the rear of the college buildings. The beds, planted mostly with silver fir, are in fine condition and divided by well-kept paths. Through years of repeated working the earth has been converted into a composite of rich soil in which there is a large admixture of forest humus. Some of the seedlings are taken up when two years old and sent to the plantation direct, without any previous transplanting. At times a free distribution of seedlings is made to farmers or landowners who may wish to reforest their denuded lands.

The nursery at Vallombrosa has a capacity of about 800,000 plants. In 1903 the species growing there, and the number of each, were as follows:

| | |
|---|---|
| Silver fir | 400,000 |
| Norway spruce | 30,000 |
| European larch | 10,000 |
| Scotch pine | 45,000 |
| Corsican pine | 32,000 |
| Austrian pine | 55,000 |
| Beech | 50,000 |
| Chestnut | 30,000 |
| Norway maple | 1,000 |
| Sycamore maple | 3,500 |
| Locust | 125,000 |
| Other species | 15,000 |
| Total | 796,500 |

Adjoining the nursery is an arboretum of several acres, mostly young trees. It contains many of our common American species, and to the forester from over the sea their familiar appearance is as welcome as the sight of old friends in a strange country. With the nursery and arboretum so close at hand, the students of the Forestry School have a fine opportunity for study and experience in this branch of silvics.

The dense forests and leafy conditions about Vallombrosa recall readily the literary quotation which has made this place so famous. The mountain slopes are thickly covered with fir and spruce, while near the college there are mixed woods of pine, locust, sycamore, mountain ash, white birch, chestnut, oak and poplar.

## France.

In a country where the forests are managed mostly under the selection system and for the formation of coppice growth, as in France, the need of nurseries is consequently not so great as in one where clean cuttings are the rule. But whatever the method employed in reforesting, there is always a need for nursery-grown plants to fill the fail places. Hence there are *pepinières* in all the forest districts of France, some of which are absolutely perfect, not only in the technical methods employed but, also, in their attractive appearance.

One of the best, perhaps, of these may be found at Xettes, in the mountains of the French Vosges, near Gerardmer, Southeastern France. The plot is rectangular, 200 by 175 feet in size, and is inclosed by a rustic fence of neat design. It is surrounded closely on all sides by a dense, high forest of Norway spruce. The ground is nearly level, with a slight slope to the south, and has an altitude of 906 meters. The neat fence, clean paths, long, well-kept beds and pretty summer-house at one side well repay the long climb up the mountain from Gerardmer to find this secluded spot. The polite and attentive forester in charge wears a distinctive uniform, as is the case in all the government nurseries and forest reviers in Europe.

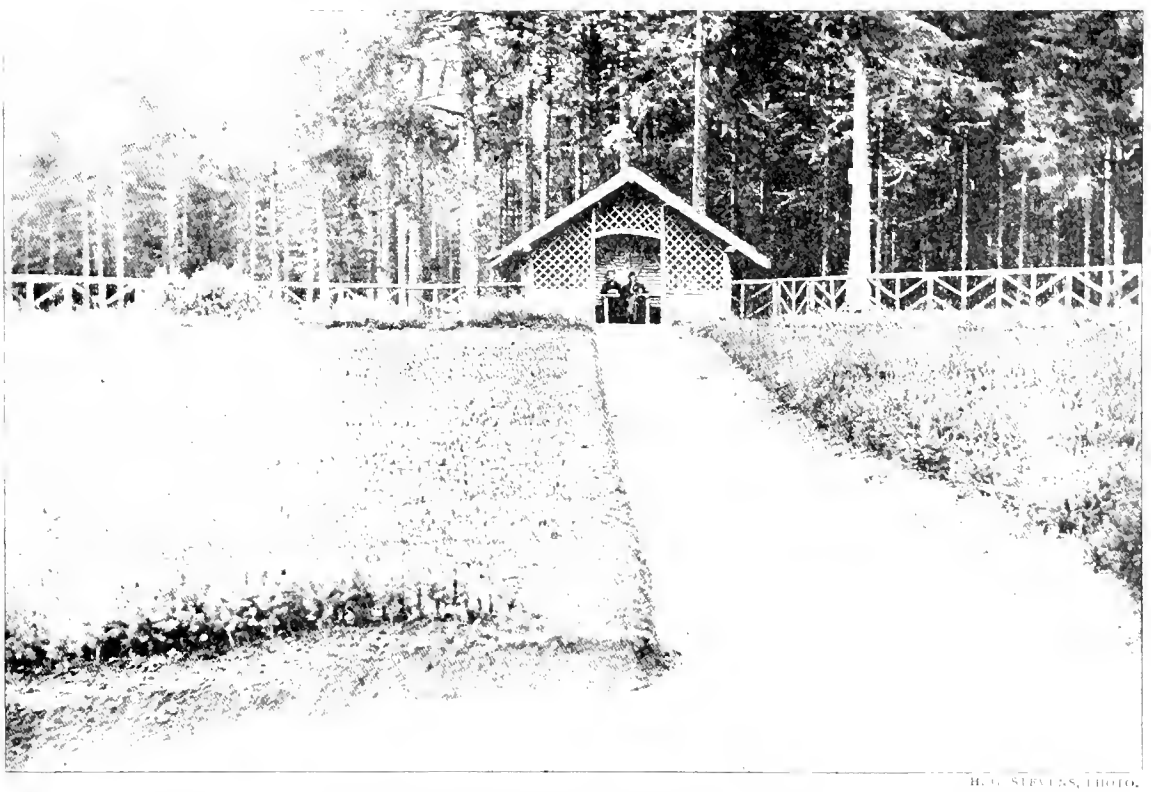
The entire area is devoted to the propagation of conifers—spruce and fir. To maintain the regular annual output nine seed beds are made, each about sixteen feet long, and inclosed in frames of wide boards placed on edge. These seed beds are covered with wire screens to protect them from the depredation of birds, and the screens are allowed to remain in place until August, or until the germination has advanced far enough to permit their removal.

The seedlings, when two years old, are transplanted into the long beds, where they remain two years more. The beds containing these transplants are four

H. G. STEVENS, PHOTO.

ROYAL FORESTRY INSTITUTE, VALLOMBROSA, ITALY

THE LOCATION OF THE NURSERY APPEARS IN THE BACKGROUND.



H. G. STEVENS, PHOTO.

FOREST TREE NURSERY, AT XEITES,

IN THE FRENCH VOSGES.

feet wide and extend from the central walk to the side of the inclosure. The seedlings are placed in longitudinal rows, the latter being eight inches apart. The natural soil is a rich loam, mixed with humus, to which fertilizers have been added each year after the removal of the plants. As a result the four-year-old transplants when taken up are strong, thrifty, and from fourteen to eighteen inches in height, with a well-developed root system. Owing to the moist climate of the French Vosges, the great altitude and the close proximity of the forest, it is but seldom that the beds require any watering.

In other districts of France many of the nurseries are used in part, and in some instances entirely, for the propagation of broad-leaved species. In the Forest of Roumare, near Rouen, there is a *pepiniere* which is stocked wholly with beech and oak. The beech is raised in seed beds, and then transplanted the same as is done with the conifers. The surrounding forests, however, are composed almost entirely of Scotch pine in pure stands. But it will be noticed throughout Northern France that, where a clean cutting occurs in a forest of the latter species, the ground is often left to reforest itself by natural dissemination.

There are several nurseries in the Forest of Rouvray — Department of the Seine — which are largely occupied by conifers, and in which the coniferous beds are frequently failures, owing to the depredation of rabbits. The foresters seemed to be unable to protect their inclosures from these pests. This is not surprising, for our American nurseries suffer serious injury at times from rodents. In the winter of 1904, after a fall of snow, one of the large forest-tree nurseries in Northern Illinois suffered a loss in white pine seedlings, caused by a swarm of field mice that cut off the stems close to the ground and inflicted damages estimated at $5,000 before their presence was discovered.

## Belgium.

Although Belgium has no place on the pages of our forestry textbooks, seventeen per cent of its area is well wooded. Its forests are of a high class that indicate an intelligent, intensive management, and the extensive formation of artificial ones is provided for by numerous nurseries.

In the great Forest of Soignes, at Groenendael, there is a *pepiniere* of two acres, in which some interesting experiments are carried on at the present time in addition to the regular work. Some germinating beds are set apart for testing the relative efficacy of various materials for covering and protecting the tender yearlings. For this purpose trials are made of straw, dead leaves, moss, dried manure, humus, plain earth pressed down around each plant and plain earth applied

loosely. The results thus far are indeterminate, but seem to favor the use of dead leaves. Mention is made of this matter here, because each of these materials is in use in one place or another.

Other beds are devoted to experiments in deep, medium and shallow planting. Thus far the best results have been attained by a medium depth in which the root-collar was slightly covered. Experiments are also being made with reference to quick and delayed transplanting. As might be naturally expected, of the plants which were set out immediately all lived, while most of those which were delayed died sooner or later, according to the period of delay.

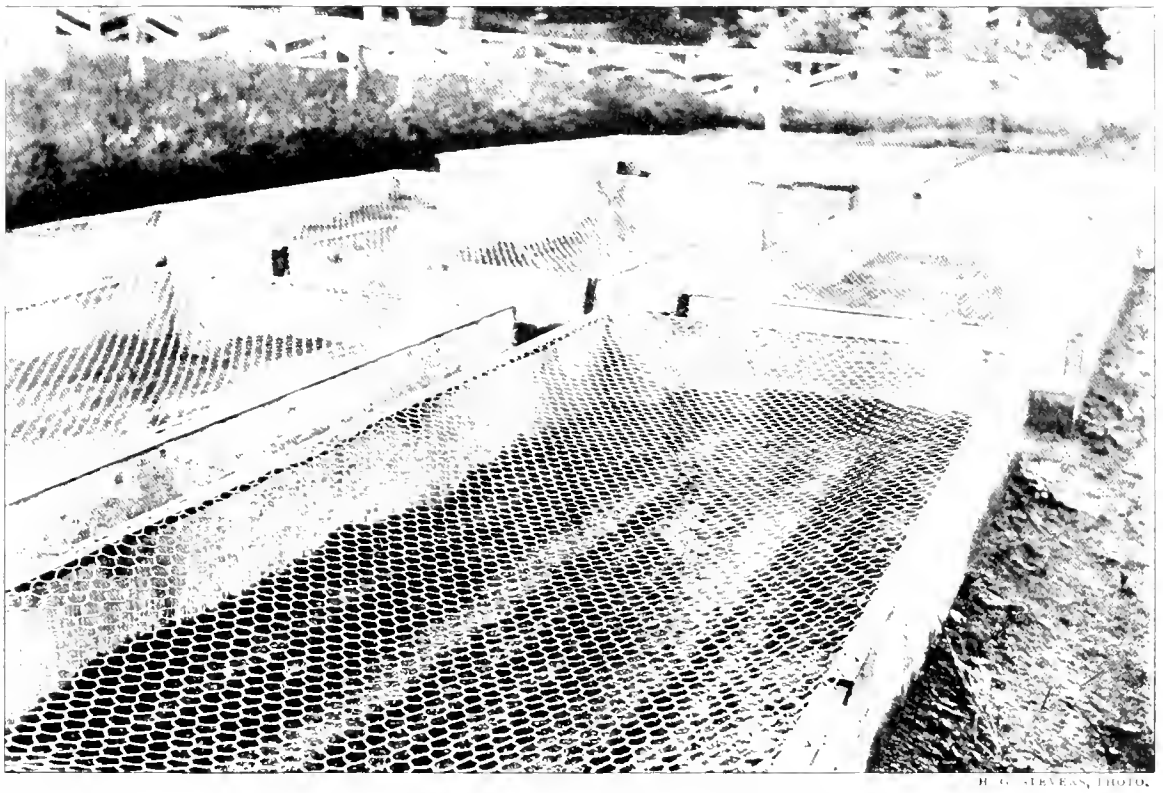
Interesting tests were made in trimming the roots of the two-year-old seedlings before transplanting. The thriftiest plants were obtained from those with uncut roots, a fact which seems to be at variance with the practice in some of the German nurseries.

Experiments were also made to ascertain the relative ability of seedlings to withstand the effects of sun and frost. While it was found that certain species were much more susceptible to injury in this respect than others, it also appeared that none were hardy enough to enable the forester to dispense entirely with some kind of protection.

In one part of the inclosure mustard plants are used to furnish shade for the tender species growing there, while some of the beds are covered with racks on which straw and brush are placed for protection from the sun. Many of the beds which had been planted with broad-leaved species contained young trees from six to eight feet high. The coniferous transplants were not over twelve inches in height, although four years old. In general, the minor details of the technical work is the same as that described later on in connection with the German nurseries.

This nursery, which is quite irregular in outline, is nearly level, with a slight slope to the south. Labels, neatly and plainly lettered, which can be read at a glance by one standing in the paths, are placed in each bed to show the species planted there. About one half of the area is occupied by broad-leaved plants, conspicuous among which are ash, beech, European chestnut and oak, the latter including the red, scarlet, English and pedunculate. This place is well worth visiting by any forester who may happen to be in its vicinity.

Adjoining the nursery, and separated by a fence, is an arboretum which was commenced in 1897, and hence the trees are small. But it already contains three hundred and twenty-one species, among which our native American trees are largely represented.



H. G. STEVENS, PHOTO.

FOREST TREE NURSERY, NEAR GERARDMER, FRANCE.

SEED BEDS COVERED WITH WIRE SCREENS TO PROTECT THE SEED FROM BIRDS.

H. G. STEVENS, PHOTO.

NORWAY SPRUCE, FOUR YEARS OLD, ONCE TRANSPLANTED.

BLACK FOREST.

## Baden.

The extensive areas of planted woods in the Black Forest require a large number of nurseries for carrying on the work and for renewing the growth on lands as fast as the timber is removed. The well-managed *baumschule* at Gernsbach, near Baden-Baden, is a fair type of the small but numerous nurseries that may be found in the various districts of the Schwarzwald.

It has a square area of about half an acre, is located in a valley running east and west, and is situated about one hundred feet above the bottom of this valley on the southern slope. The forest approaches closely on three sides, while the precipitous slope on the opposite side of the valley is also well covered with tree growth. The nursery is surrounded by a paling fence, and a good road, used mostly for hauling timber, skirts the lower side of the inclosure.

The area contains one hundred and sixty-eight beds, each fifteen feet long and forty inches wide, separated by paths of convenient width. Two broad paths, four feet wide, one running through the middle up the slope and one at right angles to it, divide it into four equal parts. The main paths which separate the beds, and which run up the slope, are three feet wide, while the crosspaths at the ends of the beds are twelve inches wide.

The earth in the beds is a rich, sandy loam, prepared by mixing one load of ordinary forest soil with one of manure. This compost, until used, is piled just outside the fence, where it is allowed to remain undisturbed for three years. Three large heaps are necessarily kept on hand to furnish the proper annual supply.

The seed beds, eight in number, occupy only five per cent of the total area. These beds have a framework of boards around their edges, eight inches high, and are covered with wire screens of a small mesh, which are kept there until the seeds have germinated to protect them from the depredation of birds. The seeds are sown thickly and broadcast instead of in rows.

If the supply of plants from the seed beds is insufficient to stock the area set apart for transplants, the deficiency is made up by gathering two-year-old seedlings from the adjacent forest.

In 1903 the species growing in this nursery were:

(1) Weisstanne, or silver fir, three and four years old.

(2) Rottanne, or Norway spruce, four years old.

(3) Sitka spruce (*Abies sitchensis*), three years old.

(4) Forle, or Scotch pine, four years old.

(5) Douglas spruce, four years old.

In addition there were, in a few beds which contained an assortment of species, some larch, sycamore, maple, Colorado spruce, white fir (*Abies concolor*) and *Larix leptolepis*.

The seedlings, as customary in most nurseries, are allowed to remain in the seed beds until they are two years old, when they are transplanted into other beds in the same nursery. These transplants are set out lengthwise of the beds in eight rows, fifty in each row, four inches apart in the row, and with a space of about six inches between the rows. This is closer than usual, but the forester claims that if the rows of transplants are set too far apart there is a tendency to fork, to the formation of two leaders, which, by the way, is one of the disadvantages urged by some against a plantation formed of nursery stock.

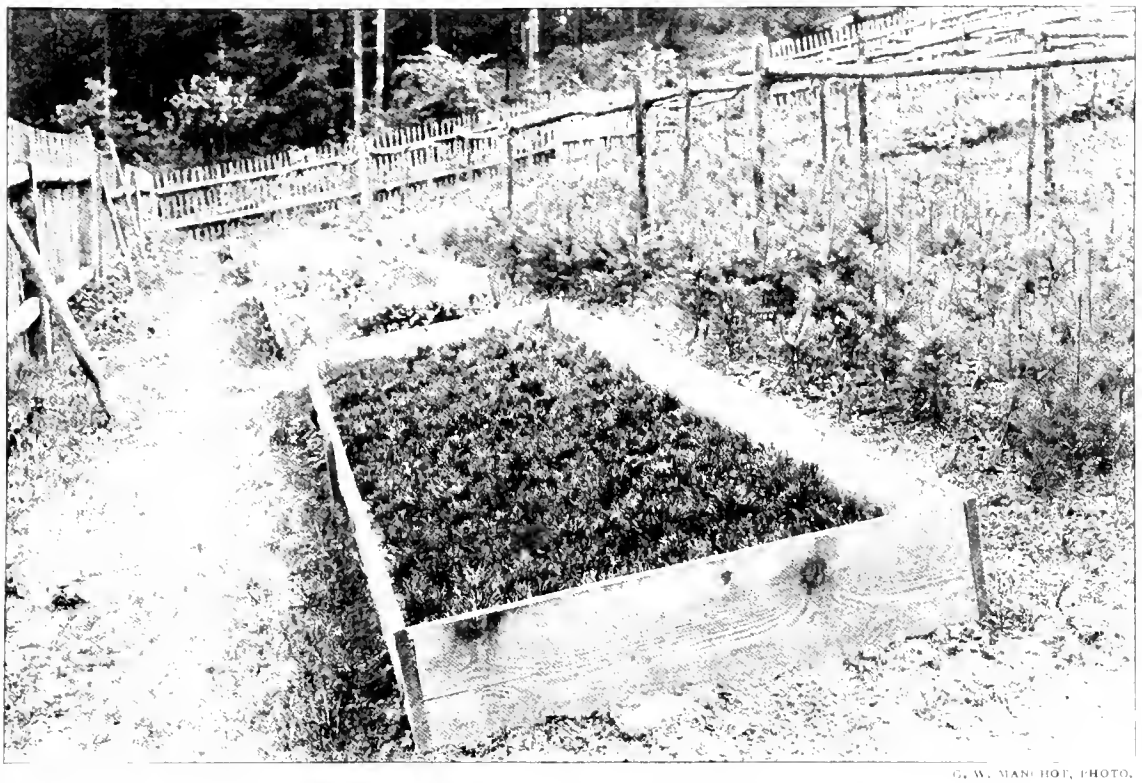
In transplanting a furrow is first made with a "hand-plough," which is drawn by one man and guided by another. Then a board with notches cut in the edge at distances corresponding to the spaces between the plants is placed on the bed with the notches over the furrow. The seedlings are then placed, one in each notch, the roots covered with prepared soil, and pressed into place. In some nurseries a planting board* is used which has half circles along the edge at the required spaces instead of V-shaped notches.

The longer roots of each seedling in the Geroldsau Nursery are clipped slightly to insure a greater amount of branching and a better root system in the transplants. This is deemed desirable by the forester, as it saves the expense of making a deeper hole when the final planting is made in the forest, and because there is less liability to loss in transplanting.

The transplants of the Weisstanne remain from three to four years in the beds, mostly four years, while the Rottanne are held in the transplant beds from two to three years, the length of time in each case depending on the height-growth attained. For the Rottanne a height of about twelve inches is deemed desirable in the transplant before removing it from the bed and taking it to the forest for final planting; but the Weisstanne, which is slower in growth, is removed from the nursery when eight or ten inches high.

At the corners and sides of each bed there are posts, about three feet high, which support long poles placed horizontally on top of the posts. If the post has no natural crotch in which the poles can rest, a hole is bored near the top of the stake and a round stick is inserted to furnish a bearing. From the first to the

*In New York we use this kind of board in our nursery work, but we set out our transplants here in rows running across the bed, which enables us to use a shorter board and to make the furrows by hand with a trowel pressed deeply into the soft earth. Furthermore, with rows placed this way a man sitting in the path can do the weeding more easily. Still, each way has its advantages, and, some disadvantages also.



G. W. MANCHOT, PHOTO.

SEED BED OF SCOTCH PINE, TWO YEARS OLD.

IN NURSERY AT GEROLDSAU, BADEN.

H. G. STEVENS, PHOTO.

BEDS OF FOUR-YEAR-OLD TRANSPLANTS, NORWAY SPRUCE.

IN NURSERY BELONGING TO A PRIVATE FOREST, GERMANY.

twentieth of May these horizontal poles are covered with brush to protect the transplants from the frost which is liable to occur in the valley.

The total number of transplants in this nursery, in 1903, was 65,000, of which 17,000 six-year-old Weisstanne were to be set out in plantations the following year. The Weisstanne formed the principal species raised in this plot, comprising ninety per cent of the plants. The Rottanne, or Norway spruce, occupied only five beds, or about three per cent of the area. There were also a bed of Sitka spruce, one of Douglas fir and one of Scotch pine. But there is another nursery in this revier, under the same förstmeister, in which the plants are nearly all Rottanne.

The cost of the plants, when placed in their final position in the forest, is from 2 to 4 pfennig (one half to one cent) per plant, a laborer being able to set out from 1,000 to 1,200 in a day. In setting out these plants in the field he uses a kind of mattock for making the holes, the same as is used in our plantations in New York. The daily wage of a laborer in this range is 1 mark 80 pfennigs, and hence the cost of annual planting in the forest, at the rate of 1,100 plants per day, is 1.6 pfennigs per plant, which leaves the apparent cost of the nursery work from .4 to 2.4 pfennig per plant, not including certain incidental expenses, which increase it somewhat.*

There are six nurseries in the Baden Revier, each about the size of the one at Geroldsau; but they vary greatly in the species propagated, some of them having ninety to ninety-five per cent of their area devoted to Norway spruce. The broad-leaved species are cultivated only to a small extent in this part of the Schwarzwald.

The nursery in the Wendlingen Revier, near Freiburg, is also devoted largely to the propagation of the silver fir. It is a permanent one, so denoted to distinguish it from the temporary ones often made to supply a local need. The natural soil is from gneiss, and is a limy sand. Manure is used as a fertilizer, that from cows being preferred. This is spread over the ground and spaded under before the seed is sown. Thomasmehl and kainit also are used.

The seeds in the seed beds are sown in rows, the rows being three inches apart, and are dropped so thickly in the row that they nearly touch each other. The beds are then covered with branches of fir or beech, which are allowed to remain all summer, at first close to the ground, after which they are raised gradually until they are about twenty inches high. These shades are also left on through the winter to keep the ground from freezing and heaving with the frost. Moss, or fine brush, laid between the rows might serve this purpose as well.

*These figures seem somewhat questionable, but they were noted down carefully from the forester's personal statement.

The seedlings are transplanted, when two years old, in rows six inches apart and at spaces in the row of about three and one half inches. They are held in the transplant beds until they are five years old before removing them to the plantations.

Although the purchase of seeds for nursery purposes is a common practice in some localities, the forester in charge of this revier gathers his own supply. As to the silver fir, a full mast occurs about every five years, although this species yields a small amount of seed each year. The cones are gathered about the middle of October. A man climbs up among the branches and breaks off the cones, which are carried immediately to the storehouse and spread out so that the air can circulate through them freely. They are stirred every day and kept in the drying-room until the scales have fully opened or fallen apart. They are then put into baskets and shaken vigorously until the seeds have fallen to the bottom, after which they are easily separated from the refuse material.

The seed beds are sown in autumn, sometimes in November or December, if snow does not fall too early. If the weather is very moist the cones may not open in time for fall planting. In that case the seed is, of course, sown the next spring.

The absence of nurseries in some parts of the Black Forest, or elsewhere, does not necessarily imply that young plants are not used there in reforesting operations. In the Sulzburg reviers, for instance, the oberförster, as explained by him, is doing very little in the way of seed plots, because he can buy seedlings from the commercial nurseries as cheaply as, if not cheaper than, he can raise them himself. This is not remarkable, as it is evident that in a nursery of one hundred acres or more, devoted solely to commercial purposes, the plants can be raised more cheaply, and with a profit, than in one of two acres, especially as in the latter case the forester has other and more important duties that engross his attention. Furthermore, under the excellent and intensive management of the Sulzburg reviers a satisfactory reproduction is obtained through natural dissemination.

## Switzerland.

As most of the forests in this country occupy slopes, more or less steep, they exercise protective functions which necessitate the selection system in their exploitation, and hence there is not the same need for nurseries as in countries where clean cutting is practiced. Reproduction by natural dissemination is largely the rule, noticeably so in the forest of the Sihlwald, famous for its intensive management and the highly profitable returns per acre which have been main-

A. KNECHTEL, PHOTO.

FOREST TREE NURSERY, NEAR LUZERNE, SWITZERLAND.

ENCLOSED WITH A HEDGE INSTEAD OF A FENCE.

A. KNECHTEL, PHOTO.

TEMPORARY NURSERY.

PATHS PLANTED PERMANENTLY WITH NORWAY SPRUCE, WHICH WILL BE LEFT IN PLACE WHEN THE STOCK IN THE BEDS IS FINALLY REMOVED. A PLANTATION THUS TAKES THE PLACE OF THE NURSERY.

tained annually for a long term of years. Still there are several nurseries connected with the management of the various cantonal forests, but the technique as observed does not vary materially from that already described.

Although nurseries are not as essential to the management of high forests in Switzerland as elsewhere, a large number are used in the work of forest extension and the formation of new forests on wild or cultivated land that had hitherto not been used for the production of timber. From 1878 to 1885 the annual output of the nurseries devoted to this purpose amounted, on an average, to 5,263,474 conifers and 351,439 broad-leaved plants.*

In the Winterthur range temporary nurseries are used to a considerable extent. In some of these, when the stock is removed, a sufficient number of transplants are left standing at proper intervals in the beds to form an artificial forest in time on the site of the abandoned nursery plot. The permanent nurseries wherever seen are in admirable condition and have an attractive appearance. One of them, near Luzerne, is enclosed by a well-kept hedge instead of a fence, as customary everywhere else, and is equipped with water pipes and several hydrants for sprinkling the beds.

In the canton of Zurich there is a nursery connected with the Forest Research Station, in which experiments are carried on with different species of forest-tree seedlings and plants. It is situated at Adlisberg, four miles from the city of Zurich, at an elevation of two thousand three hundred feet above the sea.

To determine the species suitable for planting in various parts of Switzerland, soils from these places are brought to the nursery, seeds are planted, and the little trees as they grow are studied and their development carefully recorded.

An important experiment is being carried on with the seed of Norway spruce. Good seed collected in the mountains, some from trees growing at an altitude of one thousand five hundred feet above sea level, and some from similar trees at an altitude of six thousand feet, were planted in a bed in the nursery, half of the bed being given to each kind of seed. The seedlings, now six years old, show a remarkable difference in height, those from the seed taken at the lower altitude being twenty-four inches tall, while those from the higher altitude have a height of only twelve inches.

The natural laws under which the roots of trees are developed are being studied as follows: Boxes thirty inches high, eighteen inches wide and six inches through, with the sides made of glass, are filled with earth and sunk into the ground their full length, the glass sides standing vertically in close contact with the earth outside the box. In each box is planted a tree, which, as it grows, sends some of

* U. S. Consular Reports. 1887

its roots against the glass sides. From time to time the boxes are pulled out of the ground and the root growths observed and recorded.

Observations upon white pine, Scotch pine, silver fir, beech, oak, birch and maple have been carried on for three years on plants aged from one to six years. During the winter, from November till March or April, the roots of the needle trees, as observed in the boxes, make no growth. Those of deciduous trees, on the contrary, do not go through this period with complete rest, but grow wherever the temperature becomes mild, even in midwinter. In February and the beginning of March, however, the roots show very little growth.

It is noticed that in the spring the roots begin to develop before the buds, in some cases several weeks. The larch and alder are an exception to this rule. The buds of these species have been observed to unfold even a month before the roots started.

Since the soil has a temperature below that of the lower air it follows that the roots begin their growth at temperatures lower than that necessary for the development of the aërial parts. The minimum temperature necessary for the growth of needle trees, as recorded by a thermometer placed in the boxes, is from five to six degrees Centigrade; for the maple and beech, from two to three degrees.

The roots have also a summer rest, in August and September, a time when the water content of the soil in the nursery is at its minimum. This interruption may last from three to eight weeks, according as the summer is wet or dry. Then follows in October a period of more active growth and of longer duration in the deciduous trees than in the conifers.

The most rapid development takes place at the beginning of summer. The oak has its maximum at the end of June or the beginning of July. The root growth is then about 3.54 inches a day, that of the fir and Scotch pine about 2.30 inches. From these observations a judgment is formed as to the most favorable time to plant trees in the forest. For the success of a plantation it is essential that, as soon as the trees are placed, the roots should enter upon a period of active growth to replace the water taken from the tree by evaporation. On the other hand, the plantation should be made when transpiration is at its minimum. These conditions are usually best secured in the spring. In a country, however, where the spring is usually dry and the fall mild and moist, the plantation should be made in the autumn.

For deciduous trees to grow well when planted in autumn they must form root hairs before the arrival of the great cold, and must lose very little water by evaporation during the winter. Hence, in countries where the winter is very cold and dry these, as well as the conifers, should be planted in the spring.

## Alsace.

The Oberförsterei Münster, in the German Vosges, has an area of 21,325 acres, of which one half, or thereabouts, is occupied by silver fir;* the remainder by Norway spruce, Scotch pine (1,500 acres), beech (mixed with maple), elm and carpinus (5,000 acres), oak (1,150 acres), chestnut (180 acres) and locust.

The total nursery area for the tract is four acres, which furnish an average annual output of 105,000 coniferous plants. This nursery area is in several small plots distributed conveniently throughout the tract. One of these, located about five miles from Metzeral, has an area of five ares (5,380 square feet). It is in the forest and is closely surrounded by trees. A wire fence of four strands, with a round top-rail of poles, protects it from deer. The exposure is towards the west. It has a slope of one foot in eight, terraced with retaining walls of stone three feet high.

The soil is from gneiss, with some lime in its composition. Thomasmehl and kainit are used as fertilizers;† but as kainit is strong and liable to injure the plants

* The silver fir or *Abies pectinata* of Southern Europe resembles the American balsam closely in its foliage and in many other respects, but it is much larger and taller and has a better fiber.

† *Thomasmehl* or *Thomasschlacke* (Thomas slag) is a slag or scum produced in the "Thomas-Gilchrist" process for manufacturing steel, and is obtained as a by-product from certain rich phosphatic iron ores. In this process the phosphorus of the crude iron is converted into phosphoric acid, which passes into the slag in combination with lime and iron. This slag is ground finely and sold as fertilizer. It contains from thirty to forty per cent phosphate of lime, the greatest part of which appears to be in an available condition, so that the slag, when ground or pulverized, may be used on the soil as a source of phosphoric acid without further treatment.

It is a new form of phosphate to which attention has already been attracted throughout Europe, and which has been tried experimentally to some extent in this country. From extensive trials of it at experiment stations it seems that all such slags have not an equal value, some being much more available to the plants than others. The better classes of slag have, however, given better results than bone meal, and have been sold at so low a rate the foresters can use it profitably. This slag meal is now manufactured at Pottstown, Pa., and is put on the market under the name of "odorless phosphate."

*Kainit*, or *Kalidüngung*, is a product of some salt mines, notably the mines at Stassfurt, Germany. It is a mixture of compounds containing about twenty-five per cent sulphate of potash, equivalent to twelve per cent of actual potash, together with about thirty-five per cent of common salt, some sulphate and chloride of magnesia, and a small amount of gypsum. Large amounts are annually exported to America, one year as high as 87,035 tons.

Kainit, sprinkled on manure, tends to the checking of fermentation; also, to attract and hold moisture. One precaution should be observed in the use of this fertilizer; animals should be kept away from it, as their feet may be injured by treading in it. It is better, therefore, to apply it mixed with fresh manure, and to cover the ground afterwards with some kind of litter. [See bulletins on "Commercial Fertilizers," issued by the Departments of Agriculture in various States. For further definitions of Thomasmehl and Kainit, see Illustriertes Forst und Jagd Lexikon, by Dr. Hermann von Furst. Berlin: Paul Parey. 1904.]

if applied when fresh, kali salts are used at times. This is a product of the German mines, containing about fifty per cent sulphate of potash and thirty-five per cent sulphate of magnesia.

Silver fir and Norway spruce are the species cultivated for the most part. These are transplanted when two years old, and allowed to remain until they are four or five years old before they are taken to a plantation.

In winter, to prevent the plants from heaving out by frost, they are covered with leaves from deciduous trees. Twigs of fir are stuck into the beds at close intervals, so that the wind will not disturb the leaf covering.

## Saxony.

In no European country have improved forestry methods attained a higher development and degree of efficiency than in Saxony. In the United States consular reports it is stated that there is probably no country in the world where higher revenues from the forests are obtained, nor where greater or more intelligent care is bestowed upon them, and the forestry publications, official or otherwise, issued in that country indicate that this statement is well founded. Forests of wide extent exist everywhere, not only on the Erzgebirge and on the mountains of the Saxon Switzerland, but also in the vicinity of the principal cities.

The area devoted to the formation of coniferous forests is six times that given to the growth of deciduous species. Gen. C. C. Andrews,* in his "Notes on European Forestry," says of the Saxon forests: "The entire area planted annually varies according to circumstances. On the average it will reach 6,900 acres. Of this area 800 acres are planted up with seeds, and 6,100 acres are planted up with plants." This statement will give some idea of the large number of nurseries in Saxony which are necessary in making such extensive plantations.

On the Olbernhau Revier, in the Erzgebirge, there are several nurseries. This revier contains 4,604 acres, of which four fifths is covered with Norway spruce. The nurseries are temporary ones (*saatschule unstandige*), small plots situated convenient to the areas in which the plants are to be set out.

The soil is good, consisting of disintegrated gneiss with considerable lime. For the temporary nurseries, small areas only are used. When a new place is selected for a "saatkamp," as the plot is called, the ground is not fertilized at first; but if it is used for a second crop the ground receives an addition of Thomas slag or kainit. Potash (kali) is sometimes applied instead of kainit, as the latter is too strong, and if used when fresh it injures the plants at times.

*Ninth Annual Report, Minnesota Forest Commission. St. Paul. 1904.

A. ENGLERT, PHOTO.

NURSERY WITH SEED BEDS PROTECTED FROM BIRDS AND MICE BY WIRE SCREENS AND STONE BORDERS.

AT OLBERNHAU, IN THE ERZGEBIRGE, SAXONY.

A. ENGLERT, PHOTO.

YOUNG PLANTATION OF NORWAY SPRUCE MADE BY THE SEED SPOT METHOD.

THARANDT, SAXONY.

These fertilizers are applied immediately after the plants are removed from the nursery, which is generally done in April. They are mixed with the soil, after which the ground is left undisturbed for two weeks. The beds are then made and the seed is sown in them. Where the nitrogen in the soil has been lost through washing and leaching, lupine is sown in the spring and left to grow until September, when it is spaded under.

The seeds in each row are placed thickly, nearly touching each other, in a depression made by a square-edged slat two and one quarter inches wide. The depression thus made is about three quarters of an inch in depth. The rows are about four inches apart. The beds are forty inches (one meter) wide, with intervening paths of one foot in width. For sowing an area of one are (1,070 square feet) about seventeen and one half pounds of spruce seed is used. The seeds are not soaked, but are coated with red lead to prevent the birds from eating them. After sowing, the seeds are covered lightly with sand which has been mixed with a compost made from leaves and grass.

The beds are covered with low screens of brush, preferably pine, which are left on the frame until the latter part of July. Water is not used for sprinkling unless there is a supply conveniently at hand.

Seedlings are left in the seed beds until they are two years old, when, as a general rule, they are transplanted into other beds; but sometimes they are left in the germinating beds until they are four years old, in which case they are sent direct to the field plantation. The climate in the Erzgebirge, however, is so unfavorable that the foresters deem it advisable, in general practice, to use transplants.

The expense of raising two-year-old seedlings in the Olbernhau Revier is from one to two marks per thousand plants; to prepare the soil and transplant them costs one and one half marks more per thousand; and to set them out in a plantation, from ten to fifteen marks per thousand.

Field planting by the seed-spot method, a modified form of nursery work, is extensively practiced in Saxony, and plantations of this kind are made at Tharandt, the seat of the Royal Forest Academy. The Saxon foresters generally sow the seeds along the edge of the strip or patch, where they are not so liable to be heaved or thrown out by frost. In the Erzgebirge, wherever this method is used, spruce is not mixed with pine or larch as at Tharandt. At the latter place a mixture is used to protect the spruce from the deer. A few seeds of pine and larch are mixed with the spruce seed, and as the former have a more rapid growth, and are preferred by the deer, the spruce remains uninjured.

At the Oberwiesenthal Revier, in the Erzgebirge, along the Austrian border, the technical work in the nurseries is about the same as that just described.

The nurseries are devoted almost exclusively to the propagation of Norway spruce. The soil for the most part is of a kind known there as fillet, which is composed largely of fine particles of gneiss.

For fertilizing bone meal (*aufgeschlossenes*) is used exclusively, sixteen pounds per are. In making a plot ready the trees are cut, the stumps taken out, the ground dug up and thrown into heaps in autumn, after which the bone meal is mixed with the heaps. In the following spring these heaps are spread over the ground, beds are made and sown, the seed having been mixed with lead-oxide, two pounds of the latter to sixteen pounds of seed. The depression in the bed having been made, the seed is sown thickly in them and then covered with a thin layer of fine earth that has been put through a sieve, after which the surface is pressed down gently.

Dry branches of spruce, bare of foliage, are laid on the beds for shade, and are held in place by poles laid on them. This brush is left on the beds until the plants come up through the ground, when it is removed and is not used again. Dead branches are used, because the spruce needles, which otherwise would fall on the beds, are heating in their effect and would injure the plants.

In July or August fresh humus is strewn between the rows, two cubic meters per are. This keeps the ground moist, hinders the growth of weeds and prevents heaving out by frost. This humus, composed of decayed needles, is found in the forest underneath the layers of freshly fallen leaves.

The plants are not watered. The foresters in these reviers claim that if water is once used during a drought the sprinkling must be continued until rain comes, or the plants will deteriorate in a noticeable degree.

The seed beds are made one and two tenths meters wide and of any convenient length. On a slope they are laid out lengthwise across the slope so that the flow of water from a heavy rainfall is checked or hindered. Side paths are twenty-five centimeters wide, and are made shallow, so that the beds will not dry out too much along their sides. The end paths are fifty centimeters broad, and are a little deeper. If the slope is such that there is danger of flooding and washing, a ditch is dug near the upper side of the inclosure, which is fenced for protection from deer.

As usual, the plants are left in the seed beds until two years old, when they are transplanted into other beds in the same nursery and treated with a fertilizer the same as the seed beds. At Oberwiesenthal the transplant beds are nearly square, three and five tenths centimeters on a side, with paths fifty centimeters wide.

A. KNECHTEL, PHOTO.

TEMPORARY NURSERY, NORTHERN AUSTRIA.

THE GROUND OUTSIDE THE FENCE IS PLANTED WITH FOUR-YEAR-OLD TRANSPLANTS.

PART OF FOREST TREE NURSERY, THURINGIA, GERMANY.

THE BEDS IN THE BACKGROUND, WITH ROWS SHOWING DISTINCTLY, ARE WHITE PINE.

Square beds are very unusual in European nurseries, although in some of the commercial nurseries in Germany large areas filled with transplants may be seen in which there are no paths.

A spade is used to take up the seedlings for transplanting. It is shoved down between the rows, then pressed upwards, after which the plants are gently and carefully removed by the workman with his fingers and placed in a box, the frame made of slats. The seedlings are carried to the new bed, where they are set out in drills four inches apart and the earth pressed firmly by hand around the roots. The rows or drills in the transplant beds are made at intervals of five inches. The infant trees are transplanted only once in the nursery and are left there until they are five years old, as the climate is somewhat severe. Weeding is necessary only twice a year, in the spring and fall.

In the Erzgebirge a plot is generally used for a nursery only once or twice, after which it is abandoned. If used a second time, bone meal and humus are applied in the same quantities as at first. The humus is not only a fertilizer, but it acts mechanically, making the soil looser where it is too firm and firmer where it is too loose.

Field plantations are made from the middle of May until the middle of June, the spring being late in these reviers, as they are situated 2,800 feet or more above sea level. The stumps are not removed from the ground which is to be planted, but good earth is hauled there and distributed in small heaps, and in quantities of about ten cubic meters per hectare (two and one half acres).

Transplants are taken out of the nursery bed and heeled in. At the proper time they are hauled in a wagon to the planting ground, and heeled in again as deep as they stood in the nursery. They are taken up again as fast as needed, placed in pails or baskets and carried to the men who do the planting. They are planted 1.4 meters apart, and are set in the earth that is thrown up at the side of the hole (*Hochhügelpflanzung*), two or three handfuls of the good earth being packed around the roots of each. By this method the plants receive nourishment from the grass and sod beneath the hillock.

The preparation of the ground for a seed plot costs about 22 marks per are, the expense being made up as follows: Clearing and digging the ground, 10 marks; bone meal, 1.20 marks; seed, 1.20 marks; making the beds and sowing the seed, 5 marks; covering with brush, 2 marks; lead oxide, 0.10 marks; spreading humus, 3.2 marks—or about $5.50 for a plot 33 feet square. These figures may seem rather high, but they were furnished by the obertörster from his account book.

Transplanting costs: Digging over the ground in autumn, 10 marks; bone meal, 1.2 marks; making beds, 3 marks; transplanting, 10 marks, and humus,

3.2 marks; total, 27.4 marks per are, or about $6.75 per area of 33 feet square. Removing the plants from the nursery and setting them out in a plantation costs about $4.25 per 1,000 plants, and to grow the trees in the nursery, ready for planting, about $1.75 per 1,000.

## Thuringia.

At Eisenach, in the Thuringian Forest, there is a revier of about 11,000 acres in which there are six permanent nurseries, each in the vicinity of the planting grounds where the young stock will be needed.

The soil is fertile, being composed largely of disintegrated gneiss and feldspar. The nurseries are located on gentle slopes, where the plots can have a northern or eastern exposure in order to avoid so far as possible any injury from frost, and preferably on land from which a growth of beech has been removed. In many of them sufficient space is maintained between the sides of the enclosure and the forest so that the ground will not be shaded by tall trees. Protection from wind is deemed unnecessary.

In preparing the plot the trees are cut and the stumps taken out. The ground is spaded to the depth of one foot, so that it may freeze and pulverize in the winter. In the spring it is again dug over and beds are made, thirty-nine inches wide, with narrow sidepaths one foot in width.

Fertilizers are not applied for two or three years. Then humus and rich earth are mixed with the soil immediately after the plants are removed. Seed is sown as soon as the danger from frost is passed, about the last of April. The coating of the seeds with red lead is deemed unnecessary here. The rows in the seed beds are four and one half inches apart. A narrow slat of wood, pressed into the earth with the foot, is used to mark the rows and make the depression in which the seeds are placed.

Spruce is sown twice as thickly as pine and about one fifth of an inch apart. Larch is sown as thickly as spruce, because fifty per cent of the seeds do not germinate. Spruce and larch seed is covered to a depth of a quarter of an inch with humus or sand, or with a mixture of both, while pine is sprinkled with it so lightly as to barely hide the grains from sight.

Branches of pine are then laid on the beds; but spruce brush is not used, as the dead needles, falling on the ground, are liable to become heated and thus injure the seedlings. When the plants appear and are a month or so old, the branches are placed upright for shade. These are taken off in a dry time to allow the night dew to refresh the plants, and are removed entirely when the seedlings are strong enough to do without shade.

A. KNECHTEL, PHOTO.

FOREST TREE NURSERY IN THE THÜRINGER WALD, SAXE-GOTHA.

A. KNECHTEL, PHOTO.

NURSERY PLANTED EXCLUSIVELY WITH NORWAY SPRUCE,

AT RUHLA, SAXE-GOTHA.

Ammoniated superphosphate is scattered broadcast over the beds in June, twenty grammes per square meter, preferably just before a rainfall. It may be added a second time a month later, but usually this is not necessary. In autumn moss is laid between the rows to keep the seedlings from heaving; if a supply of moss cannot be obtained conveniently, dead leaves are used for the same purpose. This covering is removed the next spring, as soon as the danger from frost is over.

Seedlings are transplanted when one year old, as they grow better than if left in the seed bed until they are two years old, and the transplanting is less expensive. The seedlings are put into water when lifted from the seed bed to prevent them from drying out in any degree whatever during the transfer. They are set out in the transplant beds two and one half inches apart and in rows five inches apart, just wide enough to permit the use of a hoe in weeding. They are left in the transplant bed two years; but if they are to be used in a plantation on grassy land they are held there one year more, or until they are four years old.

The nursery near Annathal has a rectangular area of 100 by 138 feet, sloping slightly to the southeast. The natural soil is a fertile loam, enriched by a liberal admixture with forest humus and supplemented annually with mineral fertilizers.

In the ground plan the beds are laid out sixty-five feet long and three and one quarter feet wide. A walk, three feet in width, runs across the middle of the plot and around its sides at the fence. Long paths, twenty-two in number and a foot wide each, separate the beds, with one wide path down the middle.

The seedlings in the germination beds, one and two years old,* are in rows running across the beds, the seed having been sown in furrows or depressed lines, not broadcast over the entire surface as practiced in many European nurseries. But the transplants are set out in rows running lengthwise of the beds, six rows in a bed. The coniferous species propagated in this nursery consist entirely of Norway spruce and Scotch pine. In a small portion of the enclosure there are some thrifty broad-leaved plants—horse chestnut, European alder and speckled alder.

Another nursery, in an adjoining range on the road to Liebenstein, has an area of 120 by 150 feet, and is situated on ground sloping to the south, where it is bordered on that side by a clearing of ten acres or more. The other three sides are closely hemmed in by a dense forest. The beds are three and one quarter by fifty feet, containing five rows of plants, lengthwise, mostly Norway spruce. Quite a large area, comparatively, is occupied by sycamore maples, three years old.

In making a forest plantation in Thuringia the transplants are set out by women mostly, who work for one and one half marks per day of ten hours. The

* Seed beds are made each year.

plants are placed in the field at a cost of one pfennig each, including all incidental expenses. They are planted at intervals of one meter, or 10,000 plants per hectare —about 4,000 per acre.

Most of the nurseries in the Thüringer Wald are small, each with an area of less than one acre. But at Ruhla there is a permanent one of two and one half hectares (six and one quarter acres) planted entirely with Norway spruce. In fertilizing, four centners (four hundred and forty pounds) of Thomasmehl and two centners of kainit are used for one morgen or quarter hectare. After the seeds have germinated in the seed beds ammoniated superphosphate is strewn between the rows.

The seed is sown by hand, about the end of May, in drills along the beds so that the plants can be protected with moss in the late autumn. The seed is sown thickly. No screens are used. The seedlings stand in the seed beds until two years old, when they are removed to other beds, where they remain two years more. As a general rule, four-year-old transplants are used in making a plantation.

## Prussia.

The forest at Friedrichsruh, near Hamburg, covers 18,750 acres, divided into eight reviers. The eight nurseries necessary for the annual planting occupy, in all, four hectares, or about ten acres of ground. One of the best of these is situated about two miles from the railroad station at Friedrichsruh, in the Bismarck Forest, a large tract of woodland presented to the German Chancellor by the government in recognition of his services in the Franco-Prussian war.

This nursery has an enclosure of 200 by 150 feet, is on level ground and is surrounded on all sides by an old forest, mostly beech, which comes close to the fence.

The coniferous plants raised here are mostly rottanne, with a few beds of Douglas spruce. About one fourth of the area is devoted to broad-leaf plants, the greater part of which are pedunculate oak. There is no arrangement for screening the seed beds to protect them from birds; but a stuffed hawk, perched on a stake close by, seems to answer the same purpose to a satisfactory extent.

At the Revier Hohne, in the Hartz, temporary nurseries located in the center of the planting ground are the rule. The soil, derived from granitic formations, has a natural fertility that is sufficient for the propagation of plants; but if a plot is used a second time, mineral fertilizers, of the kinds already described, are applied, with some lime (*kalk*) also in a few instances. Its elevation is only forty-five feet above the sea. In both seed beds and transplant beds the rows run lengthwise.

H. G. STEVENS, PHOTO.

FOREST TREE NURSERY, NEAR FRIEDRICHSRUH, NORTH PRUSSIA.

NURSERY FOR DECIDUOUS TREES, BISMARCK FOREST.

GERMAN FORESTERS IN UNIFORM.

As usual, in Northern Germany, spruce is cultivated almost exclusively, or to a large extent. Seed, coated with lead-oxide, is thickly sown in the germinating beds about the middle of May, in rows four and one half inches apart. Brush is not laid on the beds, as this is considered unnecessary except as a protection from birds; but moss is used to protect the seedlings during the winter. The latter is placed on the beds in October and is not removed in the spring until the snow has melted.

Seedlings are usually left in the beds two years — or one year if very strong and thrifty — and are then transplanted in rows six inches apart, where they remain two years; but if the field where they are to be set out finally is covered with grass the plants are given one year more in the nursery beds.

The Forest of Grabow, in Mecklenburg, belongs to the city. It has an area of 6,475 acres. A forester (stadtförster) manages it; a hunter (stadtjäger) protects the game, and an overseer (forstaufseher) guards it against fire and trespass. The overseers are not technically educated men, but are chosen from the ranks of the workmen. The revenues are paid into the city treasury, after which the net income is applied to the reduction of taxes. This custom is common in most of the city and communal forests in Germany.

As the soil in the vicinity of Grabow is sandy, its forests consist almost entirely of Scotch pine (*Pinus sylvestris*), a small area only being planted with spruce (*Picea excelsa*) and silver fir (*Abies pectinata*). The broad-leaved trees also occupy a small area, where the fertility of the soil may indicate their use. But the soil is very poor, to a great extent consisting of a light colored sand which, even when damp, will not cohere if squeezed in the hand.

The nursery is located at an altitude of 335 feet. In summer the temperature rises as high as thirty-two degrees (Reaumur) in the sun, and twenty-four degrees in the shade; in winter it falls as low as twenty degrees below zero, same standard. The winters, however, are mild. The first frost occurs about the middle of November, and freezing weather is liable to last until the middle of April with an occasional frost in May.

The seed for the nursery is generally purchased from commercial dealers, mostly from a seed house in Darmstadt. The seed beds require a large amount of mineral fertilizers, owing to the barrenness of the natural soil. For this purpose the forester uses Thomas meal, sixteen per cent citrates, in quantities of 880 pounds per hectare (2½ acres); carnallite, about 2,200 pounds per hectare, and slaked lime, 6,600 pounds per hectare. These compounds are mixed with fine turf, scattered thickly over the ground in winter and in the following spring are worked thoroughly into the soil. The turf is also strewn between the seedlings in the second summer of their growth.

The Grabow nursery has an area of about half a hectare. The beds are laid out forty inches wide, and of any convenient length. The sidepaths are one foot, end paths thirty-two inches, and wagon roads ten feet in width.

The seed is sown from the fifth to the fifteenth of April in rows about four inches apart and so thickly that the grains touch one another in many places. Sowing in rows instead of broadcast is done to facilitate weeding. The seeds are covered, about half a centimeter deep, with natural soil, unfertilized, which is not pressed down as done elsewhere in many instances. Scotch pine is usually sown first. No screens are used; but the beds are sprinkled daily in time of drought, enough water being used to moisten the ground thoroughly.

Scotch pine is left in the seed beds for one year only, after which the seedlings of this species are sent to the plantations. If left in the seed beds after they are one year old the crowded condition of the plants induces the fungal growth known as "*schütte*." If, however, the plants are needed for a plantation on grassy land, the seedlings are transplanted into the nursery beds, set out there eight inches apart each way, and allowed to remain another year before their removal to the field.

## Bavaria.

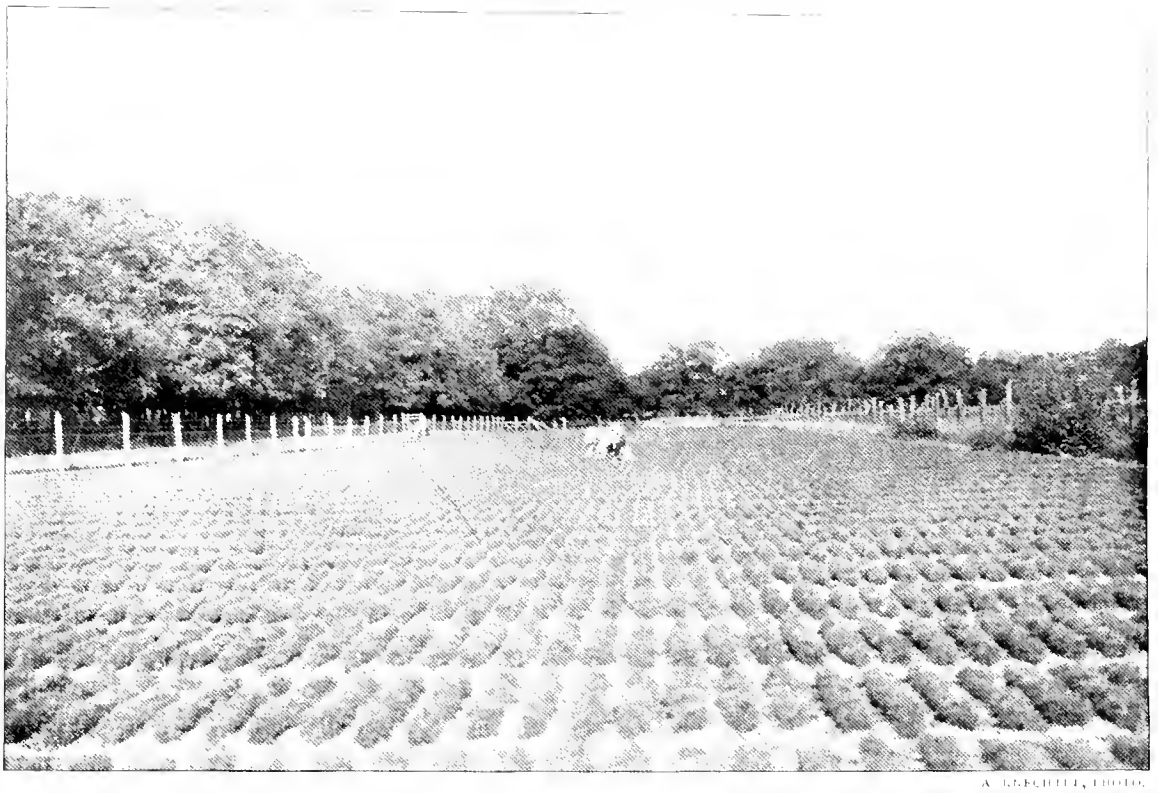
The forests in the Spessart are composed so largely of oak and beech that in this region the proportion of nurseries is not so large as elsewhere.

In the Forstamt Hain the plots are about one eighth of an acre each in size. In one of these, near the village of Hain, various coniferous species are grown — white pine, Norway spruce and larch predominating.

The method by which the beds are covered for winter is somewhat peculiar. Green branches of silver fir are used for this purpose. The beds containing white pine yearlings have each a pole fixed along the center at a height of one foot above the ground. Long branches are laid against this, with their lower ends resting on the paths between the beds. The white pine and Norway spruce, two years old, have twigs laid between the rows. The Norway spruce, one year old, is covered with the branches laid flat upon the bed, entirely covering it. The larch is left uncovered through the winter.

The nursery lies almost level. It is protected from deer by a fence of woven wire with a round top-rail, above which are two strands of barbed wire. In its minor details the management is the same as that at most other nurseries in Germany.

The methods prevailing in the various nurseries as described here will give a fair idea of the technique employed. Further examples might be given, but they would offer no additional information and would involve unnecessary repetition.



A. RIECHERT, PHOTO.

WEEDING TRANSPLANT BEDS OF SCOTCH PINE.

THIS NURSERY BELONGS TO THE CITY OF GRABOW, MECKLENBURG.

A. RIECHERT, PHOTO.

FOREST TREE NURSERY, GERMANY.

IN THE FOREGROUND ARE BEDS OF RED OAK SEEDLINGS, TWO YEARS OLD. IN THE BACKGROUND, SAME SPECIES, FOUR YEARS OLD.

## In General.

By way of summary it may be said that, in general, the following methods are observed:

In locating a nursery no great importance is attached to the question of exposure or slope, the site being selected with reference to reasons that are more essential in connection with the management of the reserve. Neither is the altitude taken into consideration, as nurseries may be found everywhere, from the low countries at sea level up to the mountain forests of the Apennines or Vosges 3,000 feet above tide. The location may be determined by the nearness of water which may be needed for sprinkling the beds in time of drought, or for irrigation. But the use of water is avoided as far as possible on account of the extra expense, and because, as claimed by some, that when once resorted to it must be continued.

Square or rectangular enclosures are generally made in order to secure a better ground plan, regularity in the form of the beds, and to economize in fencing.

In nearly every instance the enclosure is closely surrounded by a high forest that furnishes climatic protection to a great extent, although in a few localities the foresters deem the shade from the trees as somewhat of a detriment. All use carefully prepared or screened earth, free from gravel, stones and roots, to which a liberal addition of compost or mineral fertilizers is made each year.

In making the ground plan long beds are preferred, with the rows of transplants running lengthwise. But in many nurseries the seed beds are planted with cross-rows to facilitate weeding. The broadcast method for sowing seed beds, however, seems to be a favorite one. Where this is practiced the seeds are distributed thickly and as evenly as possible over the surface of the bed, after which the top earth is raked over carefully and smoothly to cover the seeds. Another method consists in spreading a very thin layer of rich, fine earth over the seeds instead of raking them under; and it is claimed that a more even catch is thus secured.

In order that the ground may attain the highest degree of fertility the forester often suspends operations in his nursery at intervals of four or five years, and, after the plants have been taken up, allows the ground to lie fallow one season, as the exposure to rain, frost and snow has a recuperative effect on the soil. Good results are further obtained by using the ground one season for an agricultural crop in the cultivation of which manure is used; and there is in addition a beneficial working or division of the soil.

The size and number of the nurseries under any one management is proportioned to the area of the plantations to be made. If two-year-old seedlings are

to be used in the fieldwork, set out at spaces of four feet each way, the nurseries for this purpose have, as a general rule, a combined area equal to one per cent. or less, of that of the planting grounds. Schlich says one half of one per cent.* But if four-year-old transplants are to be used the nurseries must necessarily have a larger area, one which in their aggregate will be equivalent to four per cent of that of the plantations. This percentage, however, applies to coniferous species only. Broad-leaf plants, which are usually set out at wider spaces, require a much larger percentage of area for their propagation. An enclosure of two acres, after setting apart enough ground for seed beds, will furnish each year about 138,000 four-year-old transplants of coniferous species, the number varying somewhat according to the space allotted to paths and roadways.

A nursery may be permanent or temporary as forest conditions may require. The latter is made in some instances merely to supply plants for some particular locality, after which, being no longer necessary, it is abandoned. If the plot will not be needed again for many years it is allowed to grow up to a young forest, some of the taller and more promising transplants being left in the beds at proper intervals for this purpose.

In most nurseries screens are used for protection against heat and frost and for protection against birds; and the beds are covered during the winter with moss or litter to prevent the seedlings from heaving. But the practice in these respects varies with the species and according to the climate or soil.

## Protection from Deer.

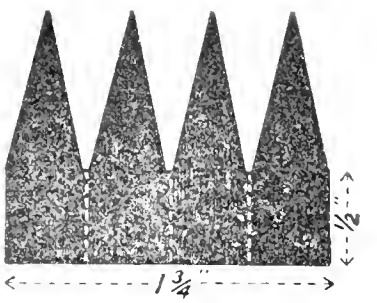
Although every nursery is surrounded by a fence or hedge to protect the stock from the deer there are often large areas just outside the enclosure, freshly planted with four-year-olds, to which these animals have access. If the leaders on the plants are cropped by deer or cattle, the young tree is retarded in growth and is liable to become distorted in shape.

At a nursery in Thuringia a large area just outside the fence was recently filled with five-year-old transplants of Norway spruce. To prevent the deer from nipping the leaders, for which these animals have a decided partiality, each plant had a sharp tin guard bent around the tip. (See illustration.) These tins before using are flat, one and three quarter inches long, one half an inch wide, and notched into four points at the top edge. This strip of tin is bent into a square, each side having a point, and slipped on the leader so that the points project above the tip. They are bought by the thousand, and are placed on the

*Schlich's Manual of Forestry. Vol. II, p. 90.

plants at a merely nominal expense. As a deer nips at the leader first instead of the side shoots, its sensitive nose receives a pricking that induces the animal to desist immediately from further effort.

This device has proved very effective. But the tins fall off in time, become rusty, and when the barefooted women and children who work in the nurseries and plantations step on one of them lockjaw is liable to ensue. Deaths from this cause have occurred so frequently that some foresters will no longer permit their use. A förstmeister at Eisenach, who deprecated their use strongly, secures protection for his plants by painting the leader on each with a mixture in which beef's blood forms a large component the putrid odor proving as efficacious and as repulsive to the nose of the deer as the sharp-pointed tin. Small wads of cotton or tow tied to the terminal buds are also used by some foresters to protect young plants, but this method requires so much time in affixing the material that it is regarded generally as expensive and impractical.




Shape of tin guard before using. It is bent square up at the places indicated by dotted lines before passing it on the tip of the leader.

## Commercial Nurseries.

The commercial nurseries in Germany are remarkable for their great areas, intelligent management and economical methods. Their annual output of plants and seedlings is figured in millions—many millions* and their superior advantages enable them to supply, at a profit, the demand from forest reviers and also from the smaller nurseries in Europe and America, the proprietors of which prefer to buy their seedlings instead of operating seed beds themselves. These commercial nurseries are well worth the careful attention and personal observation of any one who is interested in this branch of silvics.

The principal nurseries of this class are located at Halstenbek, in Holstein, and at Knittelsheim (railroad station at Bellheim), in the Rheinpfalz. The former is near the city of Hamburg, and the American forestry student who crosses the ocean on the Hamburg line will find Halstenbek a convenient place to visit in pursuing his studies. The latter is not far from the northern part of the Black Forest, and is easily reached from there.

* The advertising circular of one firm this year showing the number of plants of each species for sale indicates a stock on hand of 50,059,000 seedlings and transplants.

There are several firms at Halstenbek engaged in this business one of them having 200 acres or more laid out in beds, or large plots without paths, with an annual product of several million plants. They supply the managers of State, communal and private forests who have no nurseries of their own, or who find that they can purchase their plants cheaper than they can propagate them on their own reviers, or who may need an extra supply at times in addition to that raised on their own land. Shipments are also made to America, both to foresters and nurserymen. The latter import one and two year old seedlings, and set them out in their nurseries.

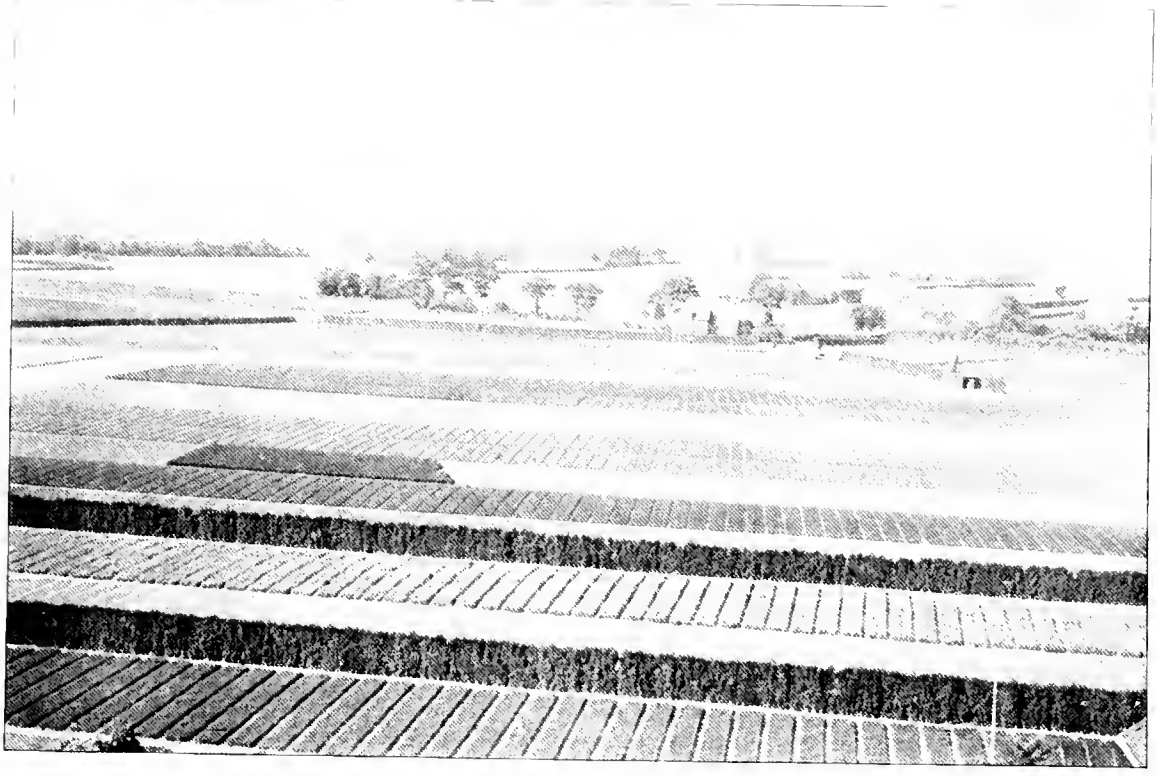
A visit to the commercial nurseries of Germany, and an observation of their immense annual output, will give some idea of the great extent which the planting of artificial forests has attained throughout Europe. It indicates clearly the practical value of the system and commands the attention of American foresters, who will find in it a good precedent for similar work at home.

A notable feature of the business at these places is their large sales of two-year-old seedlings and three-year-old transplants. The demand for four-year-old transplants is comparatively small, due largely to the extra price and greater expense of packing and freight.

The three-year-old plants may be seedlings, or yearlings that, having been transplanted, remained two years in the beds; or, two-year-old seedlings that were taken up and given one year in the transplant beds.

The prices of coniferous plants at the commercial nurseries, delivered free on board cars at the nearest railway station, are about as follows:

| SPECIES. | Age, years. | Inches. | Per 1000. |
|---|---|---|---|
| White pine, once transplanted | 4 | 8 to 15 | $2 75 |
| White spruce, once transplanted | 4 | 8 to 16 | 2 50 |
| Norway spruce, once transplanted | 4 | 10 to 18 | 2 50 |
| White pine, once transplanted | 3 | 4 to 6 | 1 75 |
| Norway spruce, once transplanted | 3 | 6 to 12 | 1 75 |
| Douglas spruce, once transplanted | 3 | 8 to 16 | 5 50 |
| Larch, once transplanted | 3 | 16 to 22 | 4 50 |
| Scotch pine, once transplanted | 2 | 4 to 6 | 1 25 |
| White pine seedlings | 2 | 3 to 4 | 1 50 |
| Larch seedlings | 2 | 6 to 15 | 2 00 |
| Norway spruce seedlings | 2 | 4 to 12 | 75 |
| Douglas spruce seedlings | 2 | 5 to 12 | 3 00 |
| Scotch pine seedlings | 1 | 2 to 3 | 50 |



A. KNECHTEL, PHOTO.

COMMERCIAL NURSERY, HALSTENBEK, HOLSTEIN.

NOTE THE HEDGES OF WHITE CEDAR, TO SCREEN THE BEDS FROM WIND.

A. KNECHTEL, PHOTO.

FIELD OF WHITE PINE, FOUR YEARS OLD, TRANSPLANTED.

COMMERCIAL NURSERY, GERMANY.

For large orders (50,000 to 100,000) a satisfactory discount is made from the above figures; but the price-lists of the nurserymen vary at times, influenced by a surplus stock or scarcity of the particular species quoted. The plants, wrapped in damp moss, are packed for shipment in large baskets, or in crates constructed of open willow-work, and an extra charge is made for packing and packages. On shipments to the United States there is a tariff of twenty-five per cent ad valorem, which together with the freight and the risk in transportation — the long time in which the plants are packed — renders an importation a somewhat doubtful expedient.

The methods employed in the commercial nurseries are substantially the same as in the nurseries belonging to the forest reviers; but more attention is paid to minor details. The supply of seed, however, is purchased from salesmen instead of collecting it from the forest. The seeds of all needle-trees are kept during winter in sacks, stored in a cool place, but the seed is not mixed with sand as advised in some textbooks. The sowing is done in April and May.

The Halstenbek nurseries are on level ground, at an altitude of only thirty-two feet above tide. The seed beds are made of black soil — a good loam that will not fall apart if pressed in the hand. Manure from the streets of Hamburg is used largely as a fertilizer, and it is scattered over the ground in winter.

The seed beds are mostly four feet wide and about sixty-five feet long. Broadcast sowing is the rule, in order to obtain a fuller utilization of the soil. If the seeds when tested show a high percentage of germination, they are sown so that the grains lie about one quarter of an inch apart; if the seed is poor it is sown more thickly. The coniferous plants are not screened; but in time of drought the beds are sprinkled, some of the nurseries having installed an irrigation plant for this purpose.

White pine, Norway spruce, balsam (*Abies balsamea*) and silver fir are left in the seed beds until two years old; sometimes the firs are left still another year. Scotch pine can be left in the seed bed only one year with safety, as the plants are liable to suffer from "schütte," a fungous disease that is developed in this species by the crowded condition of the seedlings in the second year.

White pine and Norway spruce, when transplanted, are set two inches apart in the row, if the plants are to remain there only one year; but they must be placed farther apart if they are to remain a longer time in order to permit of their increased growth. The rows are made with spaces of six inches between them, or wider if the plants are to stand there two years. These simple requirements must be observed in order to secure thrifty plants and to avoid crowding in the beds.

Scotch pine yearlings, when transplanted, are placed two and a half inches apart in the row, and the rows are laid out ten inches apart. This wide spacing of the rows is to prevent any loss from schütte. If this species is given another year in the nursery the plants must be transplanted again and given more space for growth.*

In Germany Scotch pine is generally taken directly to the forest plantations when the seedlings are one year old. If they are to be set out on grassy land however, they are allowed the benefit of one year first in a transplant bed; and if the grass is thick or apt to overshadow them too much, they are transplanted twice.

From the Halstenbek nurseries white pine is often sent to the forest when two years old, untransplanted; or three years old, once transplanted, if they are to to be used on grass land. It is claimed by the commercial nurserymen that this species grows too slim and that the root system is poorly developed if left in the seed bed more than two years.

Douglas spruce, balsam fir (*Abies concolor*) and silver fir are protected from frost for the first two years by mats made of coarse reeds supported by long poles laid along the beds on stakes one foot in height. The Douglas spruce is protected from the wind by hedges, for which purpose white cedar is planted at one side of the beds. These hedges are used to considerable extent at Halstenbek, although they are not essential to the growth of other species. They also serve to shelter the workmen from the cold winds prevalent there in spring and fall.

The seeds of most of the broad-leaved trees are sown in March and April; but the seeds of basswood, ash and thorn are kept in "seed-chests" eighteen months before planting. These seed-chests are compartments made of brick, with an inside measurement of thirty-nine inches in length, twenty inches in width, and twenty inches high. They are placed out doors, partly below the surface of the ground, in rows of ten, each row surrounded by a thick hedge of white cedar. The seeds stored in them are usually mixed with sand, although this is not deemed essential, and a mat made of straw is laid over them. With this treatment the seeds when planted germinate and come up quickly, usually in two weeks.

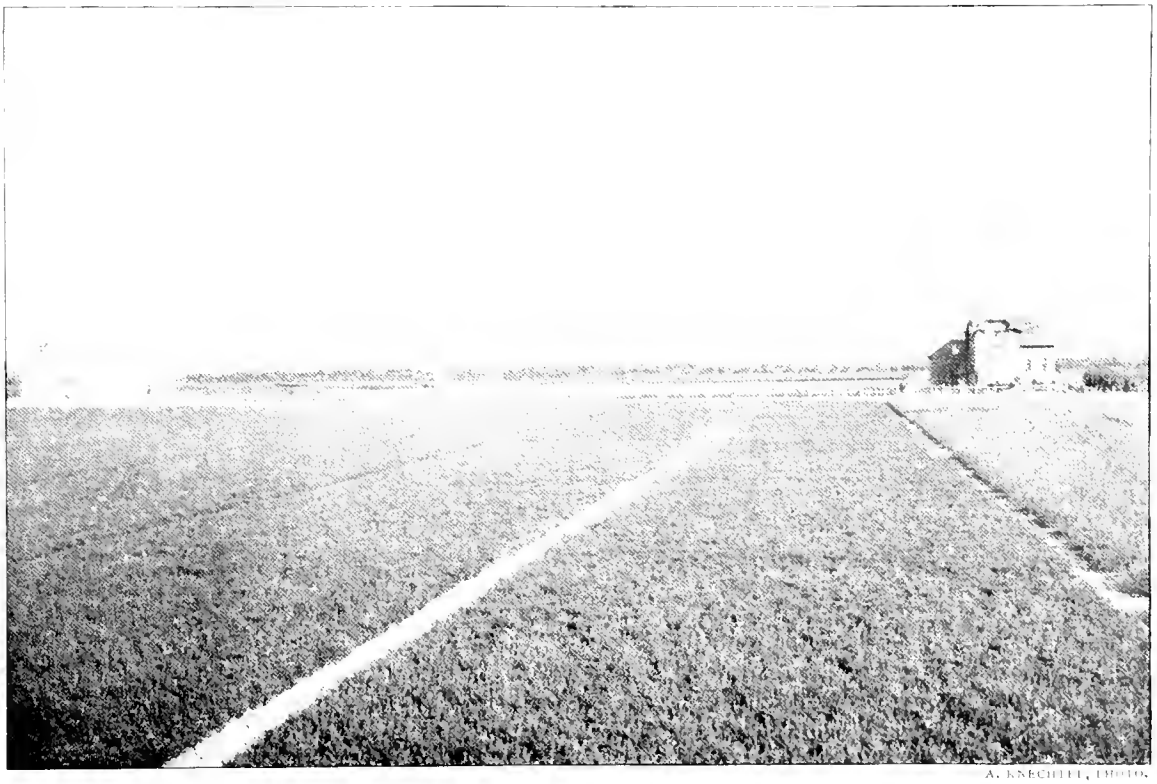
In the propagation of deciduous species, beds are made about the same as for the needle-trees, and the seeds are sown in rows lengthwise with the bed, seven rows in each. The drills or depressed grooves are made with a machine; but

*While this treatment of Scotch pine may be necessary at Halstenbek to prevent disease, in American nurseries this species is left in the seed beds two years, and in the transplant beds two or three years with perfect safety, no matter how closely the seeds may be sown or the transplants placed.

A. KNECHTEL, PHOTO.

WEEDING TRANSPLANT BEDS

COMMERCIAL NURSERY, GERMANY.



A. KNECHTEL, PHOTO.

LARGE BEDS OF NORWAY SPRUCE, FOUR YEARS OLD, ONCE TRANSPLANTED.

COMMERCIAL NURSERY, GERMANY.

the seed is sown and covered by hand. The rows are seven inches apart, but after one year the alternate rows are taken out. The seeds are sown thickly, so that the plants will stand about four inches apart.

Needle-plants are shipped in large cylindrical baskets — Scotch pine, one year old, 15,000 in a basket; white pine, one year old 30,000; two years, 10,000; three years, 7,000; and Norway spruce, two years, 15,000; three years, 8,000. Paper is laid in the basket, on the bottom and around the sides next to which is placed a layer of moss. A bunch of straw is then placed vertically in the center of the basket. The plants, which are tied into small bundles before taking them from the field, are placed in the basket with their tops towards the outside. From the center to the side of the basket three circular rows of bundles can be placed, which, however, overlap each other at one end like the shingles on a roof. Each layer of bundles is covered with loose turf before the next layer is put into the basket. The bunch of straw standing in the center permits the escape of heat, the paper prevents the escape of moisture, while the moss and turf hold the water that supplies the necessary moisture during transportation.

When a shipment is to be made the plants are lifted from the beds during the day, tied in small bundles and each bundle buried lightly in the earth, this work being done usually by women. Then in the evening the bundles are gathered and hauled to a cellar where they are packed in baskets the next day for shipment. Two men pack from 3,000,000 to 4,000,000 plants (one and two years old) in a day. The baskets are then weighed, loaded on wagons and hauled to the railroad station, which at Hadstenbek is close by the nurseries. Broad-leaf trees are put up in large bundles and wrapped in straw for shipment, the roots covered with burlap. The proprietor of a large commercial nursery at Knittelsheim, in his instructions to purchasers, says:

"Plants should be taken from the railway station promptly after their arrival. If they cannot be planted immediately they should be heeled in, care being taken that the roots are properly covered with earth. During transportation, whether on the railroad or on the delivery wagons, the plants should be covered with straw or otherwise sheltered from the sun and winds. If, on account of frosty weather they cannot be set out immediately they should be put in a cellar in upright position close together. Plants which arrive in a heated condition, as sometimes happens with Scotch pine, should be treated the same way. Immediate watering while stored in damp cellars must be avoided, or the roots will become rotten; and in no case should frozen plants be put in a warm room. It is also dangerous to hold a Scotch pine yearling in the hand longer than necessary, as the warmth will affect it unfavorably. Shortening the roots will, in most cases,

promote a better development of the fibrous growth. A sharp knife should be used, and a downward cut made. In trimming transplants it is sufficient to shorten the root-hairs merely and to remove the dead ones. Transplants cost more than seedlings; but, in most cases, it is false economy to buy the latter, for transplants are stronger have a better root system, and are more able to withstand all unfavorable influences."

## Commercial Seedsmen.

In all nurseries, whether commercial or otherwise, a supply of good seed is an important matter. To a great extent the commercial nurseries, and many of the forest nurseries as well, obtain their seed from dealers who make a specialty of collecting, preparing and storing forest-tree seed in large quantities. Mercantile houses that deal in seeds only may be found in most any of the principal cities of Europe. Having superior facilities, through specialized work for carrying on this business they are able to offer better seed and at lower prices than the nursery managers can collect it.

Seeds of the principal coniferous species can be bought from any of the large seed houses in Europe at the following rates, subject to variation at times caused by a scarcity or plenty of some particular kind:

| | Per pound. |
|---|---|
| White pine | $2 05 |
| Scotch pine | 57 |
| Norway spruce | 23 |
| Silver fir | 14 |
| European larch | 35 |

Seeds that show a very high percentage of germination may command a slightly higher price.

Their houses in which the cones of the needle-trees are dried and the seed extracted are each furnished with a specially devised apparatus. In some of them the heat is regulated by electricity in order to secure a more even temperature and thereby avoid any overheating of the ones, which would destroy the germinating quality of the seeds. They also have special facilities for cleaning, drying and storing seed; and in every detail the methods employed are based on long experience in this special work.

In any of these seed houses may be seen some kind of device or apparatus for testing the vitality of seeds and their percentage of germination, an important

item in the business. Still, in order to satisfy customers, official tests are also obtained by prominent dealers. A seed house in Knittelsheim advertises that its collections are tested for "purity and germination" by the "Swiss Control Office for the Examination of Seeds," at Zurich, Switzerland.

Foresters who gather seed for use in their own nurseries have various well-known tests of a simple character to determine its value. But there are several government stations to which samples of stock may be sent to be tested and to determine the percentage of germination. The principal ones are located at Eberswalde and Tharandt, in Germany; Zurich, in Switzerland, and Mariabrunn, in Austria.

These official tests enable the nursery manager to avoid any loss caused by sowing worthless grains, to protect himself against fraud on the part of unscrupulous dealers and to determine the quantity that should be sown.

If a report is needed immediately from the station, a number of seeds are cut open and examined for color, plumpness, taste, odor, etc. For example, the kernel of the beech and the chestnut, if all right, is white and very pleasant to the taste; that of the oak is reddish white; the maple, green; the ash, white and waxy; pine, white with a strong odor of turpentine. Coniferous seeds are crushed with the finger nail upon a piece of white paper, upon which a good seed leaves an oily stain.

If time permit the seeds may be actually germinated. The larger sorts, such as the oak seeds, are placed in vessels filled with earth, covered the proper depth, kept moist and at a temperature favorable to germination. Conifer seeds are placed between folds of flannel which are dipped into water kept at a medium temperature. There are also several forms of porous vessels made specially for such tests.

It is hoped that the descriptions given in the foregoing pages, together with the illustrations accompanying them, may be useful in calling public attention to the practical value of planted forests. In America the reforesting of denuded lands by artificial means—the formation of planted forests—is a question that sooner or later will confront our foresters. The student, on graduating from a forestry school, should supplement his course of study with a trip abroad in order to see the plantations there and the nurseries which are an indispensable adjunct to this particular system of forestry.

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